REPERTORY

OF

ARTS AND MANUFACTURES:

CONSISTING OF

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SPECIFICATIONS OF PATENT INVENTIONS,

SELECTIONS OF USEFUL PRACTICAL PAPERS

FROM THE

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OF THE

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OF ALL NATIONS, &c. &c.

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REPERTORY OF ARTS AND MANUFACTURES.

NUMBER LXXXV.

Printed by Nichols and Son, Red-Lion-Paſſage, Fleet-Street, London.

I. *Specification of the Patent granted to Mr.* John Harmar, *of Sheffield, in the County of York, Clerk; for his Invention of a Machine for raiſing a Shag on all Sorts of Woollen Cloths, and cropping or ſhearing them, which, together, come under the Deſcription of dreſſing Woollen Cloths, and alſo for cropping or ſhearing of Fuſtians.*

Dated March 29, 1794.

WITH A PLATE.

TO all to whom theſe preſents ſhall come, &c. Now know ye, that in obedience to the ſaid letters patent, and to the aforeſaid proviſo or condition therein contained, I the ſaid John Harmar do by theſe preſents particularly deſcribe and aſcertain the nature of the ſaid invention, referring to the drawings in the margin of theſe preſents, which I explain as follows; Fig. 1. (Pl. I.) a ſide and end view of ſhearing cloth from liſt to liſt. A, is the frame with its pillars, legs, and rails. B, is the cuſhion or ſhear-board over which

which the cloth is extended. C, the cropper's ſhears in their ſituation for working, with their bobs or levers. D, the harneſs or breeches fitted to each end of the riding blade of C; at the near end is hollowed the bow of C, and at both ends faſtened with ſcrews paſſing through the blade, or elſe is grooved to admit the blade and is faſtened with wedges. It is compoſed of two ſtrong pieces of plank with holes to admit ſcrews through to nut-ſcrews faſtened to their upper ſurface, and ſquare holes through which paſs ſmall pillars; other two pieces of plank are frames for wheels turning on pins (as in drawing) ſituated under the pieces faſtened to the riding blade; here the lower ends of ſcrews are rivetted to plates, but ſo as to turn, which plates are ſcrewed to the wheel-frames; alſo, in theſe lower pieces, ſmall pillars are fixed, which, paſſing through the upper pieces, ſteady the harneſs; thoſe ſcrews turned to right or left bring the edges of C to the angle of B, for the work of ſhearing. E, the inclined planes down which the wheels of D roll when the machine is working. F, is the working axle, with its rods or rails; the gudgeons of this axle reſt on the croſs rails of A; the axle has the inclination of B and E, as in drawing. Its rods, fixed to the ſides of it by projecting pieces, are about four inches from its centre, and the thimbles of G ride down them to keep pace with C in its progreſs. G, is the line communicating at the lower end by a thimble with the rods of F, and at the upper end with the bob or lever of C, as in drawing. H, is an axletree, with its handle, cog-wheel, and ſtop, fixed by ſtops, on which it turns, to the pillars of A. I, the lines communicating with the extremities of K at one end and

and the other with H. K, levers, turning on their pins, and, by the action of K and I, work againſt E, to raiſe C from B, for all neceſſary purpoſes. L, pullies in their frames, to give a proper direction to I, that the turning of H may have the effect aforenamed. M, is a crank attached to the lower gudgeon of F; the crank handle has an eye in it, through which a ſquare leg paſſes, againſt which works the lower end of a ſcrew, the nut of which is one ſide of the ſaid eye. This ſcrew, turned to right or left, looſens or faſtens the leg in the eye at pleaſure. The ſaid leg at the other extremity has a handle where the near end of the catch N is fitted on. Now, as the leg is ſhifted by means of its eye and ſcrew in that end where the handle is farther from the centre of F, N works O with more ſpeed. N, is the catch that works O. O, is the cog-wheel of N, with its ſcrew pinion on its axle. P, is an iron axle, with pullies near both ends, with a cog-wheel. R, is a ſmall ſword, fitted into the mortiſe of the projection on the lower extremity of F, and pinned, and the other end is fitted to the crank handle of S. S, is the crank axle and pulley that carries the band which goes to the power that works the machine. The ſituation for R, as to that end that fits on the crank of S, is directly behind the lower end of F, and under the farther extremity of B, where the crank end of S rides on a ſtop fixed to the farther rail of A; the pulley end where the ſtop is, rides on X. Now the crank S being put in motion, gives R the neceſſary vibration, and R works F, which alternately raiſing or falling its rods or rails by G, C works, and, to effect the progreſſion of C, F being in a working ſtate, M works N, and O

works P, and C is carried forwards by T, and to carry C forwards faster or flower, as neceffary. For the due performance of fhearing cloth, the handle of the leg of M, where N is fitted on, muft be brought nearer to the centre of F for flacking and more diftant from the faid centre, to increafe the fpeed, as then N will take more or lefs teeth in O. Or the progreffion in this frame may be effected by the method defcribed in the progreffion of Fig. 3, under the letters M, N, O, P. T, the lines for carrying forwards C by P. U, is a projection faftened to D, and works againft U when C is about to ftop. V, is a rail and fmall fword paffing through a mortife fixed to one of the legs of A, at nearly one end, and, by a working joint, goes up to near the extremity of W. W, is a lever, paffing through its fulcrum, and pinned to the upper end of X; and near the other end refts on a fmall notch, funk in the infide of the upper end of one of the pillars of A, and weighted in the extremity with lead or iron. X, is the ftep of the pulley end of S, and, by a fmall fword, goes up to W, on the near fide of one of the pillars of A, through which X goes, and moves on a pin, and is the ftep of one end of O; and the farther fide of the faid pillar, where the letter X ftands, is the ftep of the pulley end of S. Now when U or D works againft U or V, W is thrown from its notch, and W, finking, raifes X, and flackens the band on the pulley of S; then the machine ftops, and X, raifing the ftep of S on the farther fide of the pillar of A, on the near fide of it, finks the ftep of O, and the fcrew-pinion is thrown out of the large cog-wheel of P. Y, is a fmall axle on fteps, faftened to D, with its handle and bands going to near the extremity of

of Z. Z, two ſmall rails, with catches at their extremities, which fall into notches in D to faſten both the ſhears of C together. Now when the machine ſtops, by the means already deſcribed, the preſſure of the handle of Y raiſeth the catches of Z, from their notches in D, and the ſhears of C, are at liberty, and may be driven by the hand to the neceſſary ſituation for ſhifting the cloth, firſt turning H to the right, to clear them from B. The cloth being ſhifted bring the ſaid ſhears of C to their proper ſituation, and the catches of Z will faſten them; then turn H to the left, throwing back its catch, and the ſhears of C are brought to their work: when lift up to its notch, the extremity of W, and the band on S, is tightened, and the machine works.

Fig. 2, a ſide and the two end views of ſhearing the length-way of the cloth. A, the frame, with its pillars, legs, and rails. B, a circular cuſhion, or ſhear-board, formed to the angle of the cropper's ſhears, and at each end reſting on ſteps, fixed to the top rail of A, to be moved round, as occaſion ſhall require. C, the cropper's ſhears in its harneſs, or working poſition. D, the harneſs, attached to both ends of the ledger blade of the ſhears C, as particularly deſcribed in Fig. 1, under the letter D; but this mode of ſhearing requires that the ſtrong pieces, attached by ſcrews to the ends of C, ſhould be framed together near the back of the ſaid ledger blade, to take the weight of the ends of the ſhears. When the whole width of a narrow cloth is ſhorn, the ſecond ſhear of C is placed behind that in drawing, and has another, B, for it to work upon, and I, to be worked by. And that part of D attached to the heel of C and letter E, are

are lengthened as defcribed (Fig. 3) under the letter C; fo in like manner the fhears are fituated behind each other in taking the width of a broad cloth. Here it muft be noted, as in this mode of fhearing the cloth having the progreffion, the wheels of D are omitted, and pieces of wood, half rounded, fupply their place. E, is a fmall frame in its fteps, with its arms and lines. The fituation of E is feen under letter D, Fig. 3; it is attached to the heel part of the harnefs, as there feen by the drawing. One of the lines of E goes down to the working-rail of E, in the aforefaid, Fig. 3; and the other line communicates with the lever or bob of D. F, the roller, with its handle, on which the cloth to be fhorn is wound. G, the fmall rollers, to guide the cloth to B; the middle one with fwells riding on it, lighteneth the lifts of the cloth as it rides forwards: the fwells are moveable, for the purpofe of fuiting cloths more or lefs long-lifted. H, the rod, cranked on every fide, with the pulley for the progreffion, and that alfo which carries a band to the working power fituated at the upper end of A, near Q. I, is the thimble fitted on the crank, with the line going up to near the extremity of the bob working C. K, an axle, with its cog-wheel and ftop as particularly defcribed (Fig. 1) under the letters H, I, K, L, and produce a like effect, and muft be fixed to this figure the fame as in that. L, the cheek to F, faftened by a pin at the near end, and paffing under F, being hollowed to it, the farther extremity (being carried under C and B) having a weight fufpended on it. M, the roller, with a cog-wheel, to which the end of the cloth is attached; and being tightened by the handle of F, the weight on L keeps it in that

that tight ſtate as it is carried through the work. N, an iron axletree, carrying a large pulley with one groove, and a five-groove pulley with its ſteps, that out of ſight lies under A on a croſs rail. O, an iron axletree, carrying a five-groove pulley and ſcrew pinion on ſteps, as in drawing. P, bands going from the ſmall pulley of H to the large pulley of N; and from the five-groove pulley of N to the five-groove pulley of O. Now theſe five grooved pulleys gradually deſcend in their dimenſions from fourteen inches to three inches in one, and the other may be the ſame dimenſions, or very conſiderably ſmaller; or it may be reduced to a pulley of three inches diaamer with one groove. Theſe five-groove pulleys ſtand, in reſpect to each other, in contrary directions. Now when the crank by a band on the pulley on its upper extremity is ſet to work, the band B, from the other pulley, puts O and P in motion, and carries forward M. That M may have different ſpeed, the band of the five-groove pullies muſt be ſhifted for that purpoſe to the different grooves, which give them more or leſs ſpeed.

THE STOP FRAME.

Q, the ſtep where rides the upper end of H, which ſtep at one end is tenoned into the pillar of A, and pinned. R, is a ſmall ſword, at the lower end tenoned into the extremity of Q, and pinned; and at the upper end is mortiſed, ſo as to admit the farther end of S. S, is the lever, tenoned into the mortiſe of R, and pinned, and paſſing through a mortiſe in the pillar of A. Now to ſtop the machine, the near extremity of the lever S muſt be preſſed down, and that ſlackeneth

 the

the band communicating from the acting power to the pulley of H. When ſet a-going the ſaid extremity of S muſt be lifted up, and pinned there. To work this machine, put the cloth to work as directed under letter M; then throw back the ſtop of G, and the ſhears are brought to their work; then raiſe the extremity of S, and the machine works.

Fig. 3, (Plate II.) a ſecond mode of ſhearing cloth the length way: a ſide and end view. A, is the frame, with its pillars, legs, and ſide and end rails. B, the inclined plains, as Fig. 1, under E. C, the ſhear boards, over which the cloth is ſtretched from H to H: every ſhear has its board, and is placed by the ſide of each other, ſo as to take the width of the cloth; and the ſhears, ſituated for the like purpoſe on them, the harneſs H, and ſmall working frame E, Fig. 2, are lengthened accordingly. D, the cropper's ſhears in its harneſs, and bob or working lever, with E, Fig. 2, in its proper ſituations, attached by the ſteps to the harneſs of D. E, the axle, with the line communicating with the bob at one end, and at the other with one of the axle rods, by a thimble, deſcribed under F and G, Fig. 1. F, the line and thimble before named. G, a ſmall axle, with its lines, levers, pulleys, &c. particularly deſcribed under letters H, I, K, L, Fig. 1. H, rollers for the cloth, and their cog-wheels and ſtops. I, a lever, with its catch and ſtop to the wheel of H, which is on the other ſide of the pillar of A, near the middle of it, and falls into the cog-wheel of H, which line communicates with the lower end of the catches on H and L, and paſſeth through ſmall pulleys, fixed under the catches, on the inſide of the frame A, that, by the

the preſſure of the upper extremity of the ſaid lever, the catches are raiſed out of the cogs of their wheels, to give liberty for winding the cloth when ſhorn on the roller of H, ſituated near to I. K, a roller, to guide the cloth, when wound forwards, that it may keep its ſituation on the ſurface of C: it is placed near the axle G, on ſteps, in the ſame direction fixed to the pillars of A. L, an axle, with its handles, cog-wheel, and ſtop, reſting on B, with its near ſtop. This axle has an aperture through the middle of it lengthwiſe, to admit the cloth through. Now when the cloth is ſtretched from one of the rollers of H to the other, by turning L to the right more regular tightneſs is given to the cloth, and better fits it for the action of ſhearing.

For effecting the progreſſion in ſhearing and working the ſhears, M is a ſmall ſword, fitted on the handle of the projection of E at one end, and at the other on the crank handle of N. N, a crank, with its pulley with one groove, and a ſmall five-groove pulley. Or this may be reduced to a ſmall one-groove pulley, of about three inches diameter. The larger one-groove pulley carries a band to the power that drives the machine. The ſituation of this crank is nearly the ſame as S, Fig. 1, and produces the like effect. O, is an axle, with a large five-groove pulley and ſcrew pinion. Theſe pulleys of N and O have their bands, and deſcend in their dimenſions, as particularly deſcribed under letter P, Fig. 2. P, a roller, with its cog-wheel, on which the bands wind that carry forward D, with all the other ſhears, more or leſs, faſtened together by a rail, at their proper diſtances from each other, (as in drawing,) that each may take its

 proper

proper ſhare of cloth, being ſituated as deſcribed under letter C. Bands from P to D carry forward the ſhears of D.

For ſtopping this frame, the ſtop part of Fig. 1, under letters U, V, W, X, muſt be put to it, fixed to the rails and pillars of A. Q, is a projection attached to D, and will ſtop this frame when the parts above directed are fixed to it in the manner directed, Fig. 1. R, is a line attached to the ſhears of D, and paſſing through a ſmall pulley fixed in the back rail of A, runs through another pulley fixed in a convenient ſituation over the frame, of this ſaid Fig. 3, and by pulling its extremity draws back the ſhears of D when they have cut their board of cloth.

For working this machine, the cloth is wound on the upper roller of H, and round a ſmall roller at the upper end of A, and extended down C, and under K, and to the other roller of H, where it is attached; the ſtop of the upper roller falling into its wheel, the cloth is tightened by the lower roller and the handles of the roller. L, their reſpective catches falling into the cogs of their wheels, which keep the cloth in a tight ſtate, then throwing back the catch of G the ſhears of D are let down to their work, when, by means of R, they are brought to their proper ſituation on B. Then lift up the lever of the ſtop frame into its notch, as directed under letter S, Fig. 2, and the machine works. When the machine ſtops, as before deſcribed, and particularly deſcribed, Fig. 1, under X, to ſhift the cloth for cutting another length, preſs down the near extremity of I of this third figure, and wind the cloth that is cut on H. When lifting up the ſaid extremity of

of I, the cloth may be tightened as above deſcribed, and the ſhears of D ſhifted to continue their work.

Fig. 4. For raiſing a ſhag on cloth preparatory to ſhearing. A, the ſide and end rails, legs, and pillars, with its teaſle, frames, and cotters. B, the frames, one open and the other ſhut, which turn on hinges, and, when ſhut ready for work, are faſtened by buttons ſcrewed looſely to C. C, is a frame mortiſed, to fit four ſides of B, when ſhut; and by ſmall projections, or ſlides fixed to its four corners, rides in the groove of a third frame, fixed to the rails of F. D, a third frame in the inner gooves, or two ſides of it, C rides this frame, is attached to F, its projection ſlides through the gutters or flutes of L, when working. E, the double crank, with its large pulley, which by a band goes to the working power. Theſe cranks ſtand in contrary directions, on the ſame axle that the frame may work alternately. F, working rails, fitted on the crank handles, and faſtened on by ſcrews. Theſe rails have a working joint near the ſide of G, and on the farther ſide of G are attached, by ſcrews, to each end of D; and as E works the frames of D, which carry C and B, works round L, and ſo raiſe the ſhag. G, the pulleys, fixed in their frames, over which F rides. H, the board for raiſing, in its inclined poſture, with the cloth paſſing over it from one roller of I to the other. I, the rollers, ſituated before and behind H, and attached to the legs of A, by ſcrews, the gudgeons riding on ſteps; and at the upper end of H is a ſmall roller, to guide the cloth round the end of H, with ſwells for both liſts of the cloth, after the manner of Fig. 2, under the letter G. K, the

check to the fore roller I, which at one end is attached to one of the legs of A, and near that end lies over the ſame roller, and hollowed to fit it, and at the other end carries a weight, as in drawing. L, two pieces of plank, ſituated on both ſides H, at the upper termination of M. The inſide of the ſaid planks are fluted or guttered to the angles of L, which ſtands at the foot of A. The ſmall projection at the top of L is a pattern of the ſlides fixed to the ſides of D, which paſs through the aforeſaid angle when the frames are working, which raiſe them to and from the cloth. To effect the revolution of the ſlides that carry C, the top piece of L is faſtened to the ſide of its plank, at or near the upper end, by a ſcrew, on which it moves, and at near the bottom end it is faſtened to its plank, but with the liberty to play. Now when D, by its ſlides, has paſſed through the gutter, the lower end of the top piece of L falls, and forms a bridge, to carry the ſlides of L to the top of the gutter, for the making of another revolution. M, are ſmall ſwords, terminating in L, and faſtened with pins, and paſſing through ſockets fixed to the rail of A, and mortiſed at the lower extremity into N, where they move on pins. N, a ſtrong rail, extending along the ſide of A, having a joint in it, and turning on pins in a mortiſe fixed to the pillars of A. O, an axle, with ſmall projections at its ends, in ſteps, lying on the lower rail of A, extending from one ſide of the machine to the other. P, ſmall ſwords, one tenoned into the projection of O, and the other admitting the near extremity of N, through a mortiſe where it moves upon a pin. Q, an upright leg, faſtened at the lower end to the axle of O, near the lower rail of A. Now by turning this

this leg to right or left, it moves O, and, O, by its projection, raises and lowers the near extremity of N, and N raises and sinks L, which has a like effect on B, C, D; so that, by these mediums, B is brought into contact with H in all necessary degrees. R, is a cog-wheel, its situation is on the farther extremity of the back roller of I. S, two catches, for carrying forwards R, attached to I at one end in mortises, and moving on pins, and the other working the cogs of R. T, the working leg, fixed to the farther pillar of A by a screw, as in drawing. The upper extremity of the said leg goes through a socket, fixed to the farther rail of F, near the upper part of it. Now by the vibration of this said extremity of T, in its socket by E working F, S carries round R, and by varying the pins of S nearer to, or more distant from, the centre of its motion, the said R is carried forwards either faster or slower.

For shifting B and C to right and left of H, for the purpose of rasing more regularly, U, a cog-wheel and stop of the underside, with a handle near the periphery of the said cog-wheel, to act as a crank on the top side. V, three rails. The rail that crosses the top of H is tenoned into the extremities of those that form or lie to the right and left of it. W, the steps on which V rides, with pins to keep the rails of V in their place. X, bands fastened at one end to C, and the other extremity passing through nuts fixed to V, where they are fastened by the end screws working through the side of their nuts against them. Y, two legs, fastened together at the lower end by a working joint at the upper ends. The farther is attached to the near rail of F, and that nearer

works

works upon a pin, a little ſhort of its extremity, with a catch falling into the teeth of W; and as it works U round, there is another catch on the ſame ſide, which prevents the ſaid U from working back. Now F works Y, and Y works U, and U works by its crank V, and X ſhifts C from right to left by turns in the degree neceſſary by tightening and ſlackening the band X. Z, is the near ſtep of E, ſcrewed to a ſhort rail at one end, tenoned into the near pillar of A, near which the ſtep of A is ſituated. The other extremity of the ſaid rail is fixed under a pin, on a ſhort upright leg, which at the lower is ſcrewed to the inſide of the near rail of A, near which the ſtep of A is ſituated.

Now to ſet this machine to work, or ſtop it when working; for the latter, move the ſaid rail from under its pin, and by raiſing it the band on E ſlackens, and the machine ſtops; and having extended the cloth from that near roller of I, on which it is wound, to that behind H, and fix the handles in B, with its cutters, and buttoned them down, you muſt then bring the extremity of Z under its ſaid pin, and the machine works.

And I the ſaid John Harmar do hereby declare, that my ſaid invention is intended to be worked in the manner herein before particularly mentioned. In witneſs whereof, &c.

II.

Fig.1.

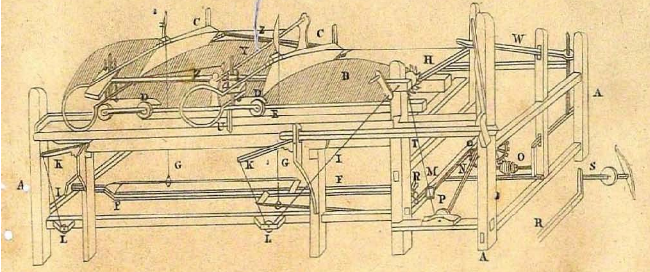


Fig.2.

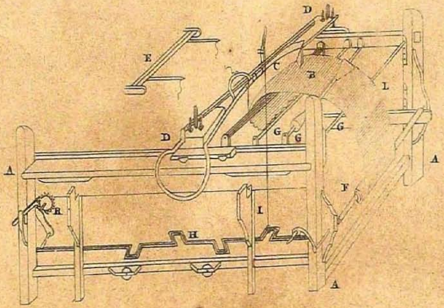
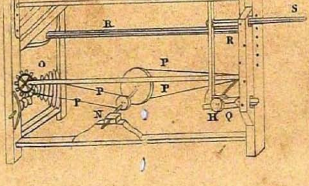


Fig. 2.



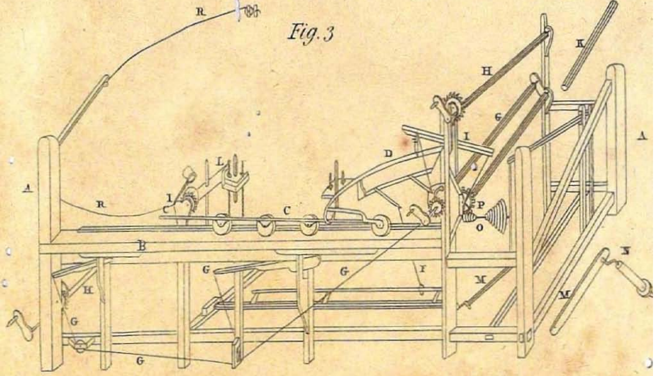

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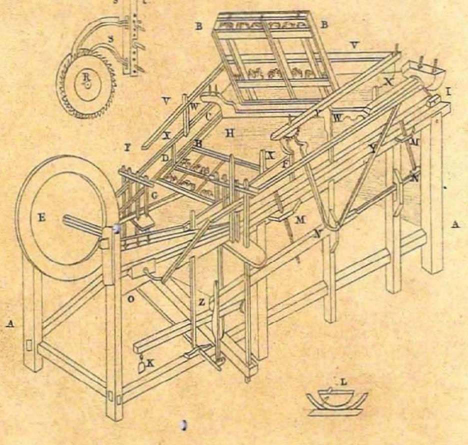
Fig. 3

Fig. 4.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II. *Specification of the Patent granted to Mr.* Thomas Grace, *of Neat-House, in the Parish of Saint George Hanover-square, in the County of Middlesex, White-lead-maker; for a new Method of making an Acid for corroding Lead, and for other Purposes; and also of a new Method of preparing and making White Lead, either with or without the said Acid.*

Dated December 30, 1800.

TO all to whom these presents shall come, &c. Now know ye, that I the said Thomas Grace, in pursuance of, and in compliance with, the said proviso, do hereby declare, that my method of making the acid is as follows: Instead of using common water, which is generally used with malt, sugar, syrup, or molasses, or other ingredients, in the usual way of making such kind of acid, I substitute the water which wheat or any other substance has been steeped in, for the purpose of making starch, which the starch-makers call sour water; or I take the wash or residuum after the distillation or rectification of spirits, which is commonly of little use; to either or both of which I sometimes add the water upon which turpentine has been distilled, and which, in distillation, comes over with the oil of turpentine, and is then separated from it, and usually thrown away; to these I add a quantity of molasses, syrup, or sugar, in the proportion of half a pound to a gallon of either the sour water, or distillers' or rectifiers' wash, or residuum or mixture of both, or more or less than half a pound, according to the intended strength of the acid, and ferment them in the usual manner, as follows. I fill

fill a large vat or back, which has a falſe bottom, full of holes, half full of rapes or raiſins, from which wine has been made, and then fill up the vat or back, with the liquor compoſed of, or produced by, the ingredients before mentioned, and let them remain together about twenty-four hours. I then draw half of the liquor off, and return it when the rapes or raiſins are ſufficiently heated; and thus I continue the operation till a proper acid is produced, which will commonly be done in the ſpace of fourteen days, or thereabouts. This acid I uſe for corroding lead, and for other purpoſes; the eſſence of its invention, and the difference from the uſual mode heretofore adopted for making ſuch kind of acid, being in the ſubſtitution of the aforeſaid ſour water, or waſh or reſiduum, or both, in the ſtead of common water, with the optional addition of the turpentine water before deſcribed. Inſtead of the uſual method of corroding lead, for making white-lead, by ſpreading upon the floor a bed, ſtratum, or layer of horſe-litter, or tanners'-bark, upon which pots filled with acid are placed, and over which ſheets of lead are ſuſpended or laid for the purpoſe of being corroded and made into white-lead, I place rapes or raiſins after they have been made uſe of by the wine-makers, or hops after they have been uſed by the brewers, and which are uſually thrown away, or grains after the brewers or ſtarch-makers have done with them, either alone or with a ſmall quantity of horſe-litter or tanners' bark, or both. And this method which I have invented may be uſed with the before-mentioned newly-invented acid, or with any of the acids generally uſed for corroding lead. In witneſs whereof, &c.

III.

III. *Specification of the Patent granted to Mr.* George Holland, *of Broad-ſtreet, in the Pariſh of Saint George, Bloomſbury, in the County of Middleſex, Frame-work-knitter; for a Method of making Stockings, Gloves, Mitts, Socks, Caps, Coats, Waiſtcoats, Breeches, Cloaks, and other Cloathing and Linings for the ſame, for Perſons afflicted with the Gout, Rheumatiſm, or other Complaints requiring Warmth, and for common Uſe in cold Climates, and for making falſe or downy Calves in Stockings.*

Dated September 22, 1788.

To all to whom theſe preſents ſhall come, &c. Now know ye, that the ſaid George Holland doth, by this preſent inſtrument in writing, under his hand and ſeal, by him duly executed, and intended to be inrolled as aforeſaid, teſtify, declare, and deſcribe, the nature of his invention, and in what manner the ſame is to be performed, to be as follows; that is to ſay: having the common ſtocking-frame, twiſted ſilk, cotton yarn, flaxen or hempen thread, worſted or woollen yarn, or any ſuch like twiſted or ſpun materials, begin the work in the common manner of manufacturing hoſiery, and having worked one or more courſe or courſes in the common way, begin to add a coating, thus: draw the frame over the arch, and then hang wool or Jerſey, raw or unſpun, upon the beards of the needles, and ſlide the ſame off their beards upon their ſtems, till it comes exactly under the nibs of the ſinkers; then

ſink the jacks and ſinkers, and bring forward the frame, till the wool or Jerſey is drawn under the beards of the needles, and, having done this, draw the frame over the arch, and place a thread of ſpun materials upon the needles, (under the nibs of the ſinkers,) and proceed in finiſhing the courſe in the uſual way of manufacturing hoſiery with ſpun materials. Any thing manufactured in this way has, on the one ſide, the appearance of common hoſiery, and on the other ſide the appearance of raw wool. The raw or unſpun materials may be worked in with every courſe, or with every ſecond, third, or other courſe or courſes, in quantity proportioned to the warmth and thickneſs required. The above-mentioned raw or unſpun materials may be fixed alſo thus: having drawn the frame over the arch, hang them upon the beards of the needles, ſlide them off the beards upon their ſtems, and without ſinking the jacks and ſinkers, draw the frame off the arch, and bring the raw or unſpun materials forward under the beards of the needles; then draw the frame over the arch, and proceed in finiſhing the courſe, as before directed. The ſaid raw or unſpun materials may be fixed likewiſe thus: hang them upon the beards of the needles, without having the frame over the arch, and ſlide them off their beards upon their ſtems; then bring forward the frame till the raw or unſpun materials are drawn under the beards of the needles, and, having done this, draw the frame over the arch, and proceed in finiſhing the courſe as before directed. Hoſiery may be coated by any of theſe methods, not only with wool and Jerſey, but alſo with ſilk, cotton, flax, hemp, hair, or other

other things of the like nature, raw or unſpun, but the method firſt deſcribed fixes them moſt firmly. The common ſtocking-frame is mentioned above, but any other frame, upon a ſimilar principle, may anſwer the purpoſe. The method of making the falſe or downy calves in ſtockings, is by working raw or unſpun wool, or Jerſey, or any other raw or unſpun materials, into the calves of ſtockings, in the different methods before deſcribed, and to any required form and thickneſs. In witneſs whereof, &c.

IV. *Specification of the Patent granted to Mr.* EDWARD SIMPSON, *of Lilly Pott-lane, in the City of London, Straw Hat-manufacturer, and Mr.* CALEB ISBESTER, *of Banners-ſquare, in the Pariſh of Saint Luke, Old-ſtreet, in the County of Middleſex, Cabinet-maker; for a new and improved Manufacture of Straw Plat, made of ſplit Straw, preſenting only the outſide Surface of the Straw to the Eye, and alſo of other Plat of ſplit Straw laid, put, or ſtuck, upon Silk, Paper, or Wood.* Dated May 8, 1800.

WITH A PLATE.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with, and performance of, the ſaid proviſo, we the ſaid Edward Simpſon and Caleb Iſbeſter do hereby deſcribe

ſcribe and aſcertain the nature of the ſaid invention, and in what manner the ſame is to be performed, in manner following; that is to ſay: To make plat of ſplit ſtraw, preſenting only the outſide ſurface of the ſtraw to the eye, take ſtraw, of any ſize, and ſplit and fold the ſame to the ſize wanted, in manner and form as is deſcribed in the drawings in the margin hereof, (ſee Fig. 1. Pl. III.) oppoſite to the letters A and B; when the outſide ſurface of the ſtraw only will preſent itſelf to the eye, and the ſame will anſwer every purpoſe of, and appear like, a curious fine ſtraw flattened, and make the ſame into plat. And to make plat of ſplit ſtraw, laid, put, or ſtuck on ſilk, paper, or wood, take ſtraw, and ſplit and open the ſame, and lay, put, or ſtick the ſame, with paſte, gum, or any other thing fit for the purpoſe, on ſilk, paper, or wood, and cut the ſame into any ſize ſlips, which may be wanted, and make the ſame into plats. And the ſaid Edward Simpſon and Caleb Iſbeſter do hereby declare and affirm, that the particulars above ſet forth do contain a full, true, and perfect, deſcription of the nature of the ſaid invention. In witneſs whereof, &c.

V.

V. *Deſcription of a Steam-Flue for Hot-beds, by applying the Steam of hot Dung, through leaden Pipes, to keep the Beds of a conſtant and regular Heat.*

By Mr. Richard Weston, *of Leiceſter.*

Communicated by the Author.

HOT-BEDS are of ſuch general uſe in the modern art of gardening, that any method of improving them deſerves the notice of every gardener.

The plan of a water-flue, which I ſent you, and is publiſhed in your Thirteenth Volume, Page 238, is capable of being employed in a double manner; that is, it may convey heat into a hot-bed, either by the ſteam of water, or of dung. In places where hot water cannot ſo conveniently be procured, and where there is plenty of dung, this will be found very uſeful.

Thoſe perſons who already have a water-flue, may alter it for the expence of two or three ſhillings, to anſwer both purpoſes.

The alteration neceſſary conſiſts in changing the pipe *d* (See Vol. XIII. Plate VI.) of one inch diameter, (which is to draw off the water when cold,) into a larger one of three inches, and to have the head of a watering-pot of ſix inches diameter made of tin, with a pipe of one foot long to put on it, with holes of a quarter of an inch wide to admit the ſteam, both in the pipe and roſe.

When you chooſe to heat a hot-bed with ſteam, the bed muſt be made in the uſual manner, except,

cept, that in the front, or at one end, with oblong pipes, the dung ſhould be laid about a yard ſquare, to form a ſtrong body of ſteam, to paſs into the flues, and convey the heat to the earth, and the roots of the plants; but three good corks muſt be firſt put into the two upright ſteam-pipes within the bed *e e*, and the one on the outſide *c*, by which the flue is filled with water, to prevent the ſteam from paſſing off through them.

To examine the heat of the bed at any time, draw out the cork, and the heat of the ſteam will inform you of the condition of the bed. If declining too much, the dung muſt be ſtirred up, and freſh added.

If at any time dung cannot be readily procured, it may inſtantly be converted into a water-flue.

On applying to the plumber, who has made ſeveral, I find, that inſtead of their being made oval, if two pipes of eleven feet long each, (for a nine-feet frame) turned up a foot at one end, to fill them with water, and one or more upright pipes to each in the middle, to convey the ſteam of the hot water into the bed, be laid lengthways in the bed, about three feet aſunder, there will be a ſaving of ſix or ſeven ſhillings on account of leſs ſolder, and trouble in making, and will be found rather more convenient, as I have juſt had one made which is at work.

The uſe of ſteam from hot water has alſo been proved by a gentleman here, who obſerved his cucumber-plants declining in vigour, and not having a water flue, placed four jugs in the bed, and filled them with hot water for three nights, till the freſh lining took effect, which inſtantly recovered his plants; he has ſince had a flue.

But

But ſince writing the above, the introduction of ſteam from hot water, in increaſing the growth of cucumbers is very ſtrongly proved from the experiments of Mr. Wakefield, publiſhed in your laſt volume, page 235.

In a frame conſiſting of three lights, I would therefore propoſe four, or even ſix ſteam-pipes, and if the top of each be enlarged to four inches diameter, in the ſhape of the bottom of a trumpet, it will convey more ſteam into the bed.

a, (Fig. 2, Plate III.) the pipes to fill them. *b*, ſteam-pipes. *c*, to draw off the water, or put on the roſe when converted into dung ſteam-pipes.

From the proofs alſo of ſteam being ſo advantageous to cucumbers, I would recommend a pan, made of copper, braſs, or lead, (ſix inches wide and three deep, with a pipe, one foot long, to come through the end of the frame, to draw off the water when cold,) to be placed at the back of the hot-bed-frame, to be filled with hot water at night, and if neceſſary again in the morning.

If a hole be bored aſlant through the back of the hot-bed-frame, the pan may be filled with hot water, without the glaſs being taken off; and I would rather recommend the flues to be four inches diameter within, than three, becauſe of containing more water or ſteam.

VI.

VI. *On the superior Advantage of setting Potatoes in Rows, with a Hoe, or drilling, instead of dibbling them. With a Description of a Machine for washing them.*

By the Author of the preceding Paper.

AS government is now giving premiums for cultivating potatoes, the most advantageous method of raising them becomes a great national concern; and to those persons who have not been used to cultivate them, some instructions may be of advantage to them.

The most common method is setting them with a stick, shod with iron, and generally in a promiscuous manner, without being planted in rows. The stick consequently in making the hole hardens the earth around it; and unless the potatoe set, exactly fits the hole and falls to the bottom, must leave a hollow; and if much rain falls soon after, and the ground be stiff, will retain the water, and probably may cause many of them to rot.

On the contrary, when the ground is ready for planting, either by digging or ploughing, if in a field, let a drill be made with a plough, at the distance you mean to plant them, which should not be closer than eighteen inches, and let a boy follow and drop the sets in at eight or ten inches distance, and they may afterwards be covered with the plough.

If planted in a garden or small piece of ground, put down a line, and draw the drills with a hoe. When planted, let the drills be filled up with a hoe or rake. The consequence will be, that by those

those operations the young shoots, either for forming roots or stems, will have fine pulverized earth to strike into; and if you try some both ways, the quickness of the growth of the drilled, in preference to the dibbled, will soon convince you of the superior method.

As a proof of what is here recommended, a field, of nearly an acre, was last April prepared for planting potatoes, manured and digged equally alike, all the ground of equal goodness, and planted the same day.

In June the potatoes of one part were observed to be six inches higher than the other part, and continued so till they were fit to take up, which was one month earlier than the others; they were also larger, and produced one-fourth more than the other in quantity.

During the summer, the hoeing of the whole field was equally performed on every part, and the difference could only be attributed to the drilling instead of dibbling them. There is also this farther advantage in the hoeing, that when in rows they can be done quicker, and the earth drawn up to them better, and are more readily taken up.

DESCRIPTION of the MACHINE for washing POTATOES.

The machine should be made similar to a barrel-churn in shape, three feet four inches long, and twenty-one diameter; the ends of oak or ash; the bars two inches broad, with a vacancy of two inches between each; an iron spindle an inch and a half square, or three inches, if of oak or ash; a handle at each end to it, like a grind-

ſtone; and a door, with iron hinges, twelve inches by ten.

When the machine is uſed, it is to be filled with potatoes, and placed over a tub of water; but the moſt convenient method is a trough, placed under the ſpout of a pump, raiſed up to a proper height for men to work at it, with a wooden plug to a hole in the bottom to let off the water when dirty.

The length of the trough muſt be in proportion to the machine, and the ſpindle to correſpond with it, with a piece of iron placed on the top of the trough, for the ſpindle to reſt on, to prevent the trough from being worn.

When the machine is filled, if the potatoes remain ſome time in the water to ſoak, and now and then turned before you work the machine, it will greatly facilitate the waſhing.

VII. *Deſcription of a Machine called a Speedy Elevator.*

By NICHOLAS COLLIN, *D. D.*

WITH A PLATE.

From the TRANSACTIONS of the AMERICAN PHILOSOPHICAL SOCIETY.

Dr. COLLIN *was honoured with the Magellanian Gold Medal for this Invention.*

THE main body of the baſe is a rectangular ſolid floor. (See F. W. Fig. 3, Plate III). To its corners

corners are jointed four horizontal legs, of equal thickneſs with it, but half the length, having their nether ſides even with its bottom. When the machine is uſed, theſe are diſplayed ſo that their ends form a rectangle; the diagonals of which may be on thoſe of the main body, or vary from them in a poſition moſt promotive of ſtability.

The pillars AA ſtand vertical on the long diameter of the baſe, equally diſtant from its ends. Their feet enter into it, and are by ſtrong faſtenings incorporated with its body. Theſe pillars are pairs. Their form is a rectangular parallelipiped. Their inner ſides have grooves from top to bottom, which terminate by offsets in cylindric ſegments. Near the tops are central embrazures, whoſe ſides are fortified with iron plates that reach within the ſolid parts above and below. The pulleys are of metal, with ſteel axes and braſs naves for eaſy turning, and deep channels for ſecuring the cords.

The pillars are joined by three pairs of ribs. Theſe are rectangular; wide, but comparatively thin; placed horizontally, between the tops and embrazures, about the middles, and near the feet. Their ends are cloſely fitted within the pillars, and well faſtened.

The piers BB are more ſlender than AA; with ſhorter heads; but the length of their bodies is equal to the whole of theſe *. They have ſimilar grooves, embrazures, pulleys, and joining ribs. Their faces are parallel rectangles. The backs of their bodies have tongues along the middles that

* I call the part about the embrazure *neck*, that above *head*, and that below *body*.

fit the grooves of AA. Theſe are vertical rect-angular ridges, and parts of the very pieces, formed by cutting down both ſides to a proper level. Theſe lower ſurfaces, being even and ſmooth, will thus move cloſe along the corre-ſponding plain parts of AA while the tongues glide in contact with the ſides of the grooves.

The cords *aa* are well paired in length and tex-ture. They ply over the pulleys of AA in the ſaid hollows behind the grooves; having their ends fixed under the feet of BB, and on the boxes of the windleſs. This is well ſecured in the baſe, cloſe to and right beneath the pillars.

The cords *bb* are faſtened by one end on the heads of AA. They paſs over the pulleys of BB, and reach as far below them as *aa* reach below the pulleys of AA, which is the diſtance of theſe pul-leys from the baſe. Their other ends are tacked a little above the bottoms of the piers CC.

Theſe piers are with their apparatus framed like BB; have leſs bulk and ſhorter heads. Their pulleys clear the tops of BB when the machine is down.

The cords *cc* have the ſame length with *bb*, below the pulleys of CC; plying over theſe; faſtened on the heads of BB and ſomewhat above the bottom of the pier D.

This is a ſingle piece. It has two backs to fit the grooves of CC, formed like the backs of the other pieces.

A frame is accurately fixed and poiſed on the top of D. In this the load L is placed, ſo that its centre of gravity is exactly or very nearly over the centre of the frame.

When the power begins to wind the cords *aa*, theſe raiſe the piers BB. As they riſe, their pul-

leys recede from the tops of A A, and by ſtretching the cords *b b* lift the piers CC. Theſe recede at the ſame time from the tops of BB, and lift the pier D. Thus while BB are wound up from the baſe to the height of the pulleys of A A, D riſes treble that height; and, however great may be the number of moving pieces, it multiplies the celerity and acquired elevation of the uppermoſt by that of the firſt.

As the duration and celerity of all the movements is the ſame, the lengths of all the cords below the reſpective pulleys muſt be equal.

As the whole acquired elevation is by thoſe parts of the piers which are drawn out of their folds, theſe ought to have a very great proportion. Therefore B B reach the baſe when down; and the heads of A A are but long enough to keep them ſafe in their grooves, when drawn up. Again, as the ends of the cords *b b* will be above the baſe according to the length of the heads of A A, the heads of BB are ſhortened, and the bodies of CC are prolonged below thoſe ends, in order to ſave room, and yet afford theſe piers a ſecure depth in the grooves of B B, when drawn up. On the ſame principle the heads of C C are ſhortened, and a part of D left under the ends of *c c*. As theſe additions of ſaid pairs cannot increaſe the elevation, the cords ought to be fixed above them in order to ſhorten the bearings, and ſo far make the bodies firmer. In a longer ſeries of piers this ſhortening of the heads can only be continued to the limit of depth neceſſary to ſupport the ſtrains.

The pier D preſſes the cords *c c* by its own weight, and the load L. This preſſure cauſes an equal pulling and conſequential reſiſtance in the

tops of the piers B B. The pulleys of the piers C C muſt bear this double preſſure $= 2\,L + 2\,D$. Theſe therefore preſs the cords *b b* with ſaid weight and their own $= 2\,L + 2\,D + CC$. This doubled $= 4\,L + 4\,D + 2\,CC$ is the preſſure on the pulleys of BB: But their heads are pulled up by $L + D$: The difference of theſe forces added to their own weight is the preſſure of theſe piers on the cords *a a*, $= 3\,L + 3\,D + 2\,CC + BB$. The power on the windlaſs muſt be equal to this.

In any ſeries the power muſt lift a weight equal to the firſt piers, double the ſecond, and ſo forth, till the laſt pier and its load multiplied by the number of moving pieces.

The pulleys, cords, and ribs have ſome weight, and are to be counted as parts of their reſpective piers. A competent allowance is likewiſe required for the friction of the pulleys, which impedes the aſcent, though the deſcent is advantageouſly retarded by it.

The preſſure on the pulleys of the pillars A A is double the power. The ſtrain in their tops is half of the weight on the pulleys of B B. The difference of theſe forces, $= 4\,L + 4\,D + 3\,CC + 2\,BB$, added to their own weight is the preſſure on the baſe.

The ſtrain in the tops of any piers in a ſeries is equal to what the power would be, if the pair next above was the laſt. The weight on the pulleys of the ſame pair is double the ſtrain in the tops of the pair next below. The ſtrain on their feet is equal to the ſtrain in the tops of the piers two ranks below.

It is very neceſſary to compute the ſtrains and preſſures in order to ſecure all the parts, and to ſave needleſs bulk, which would be a great diſadvantage

vantage in the piers by the additional expenſe of power. The preſſure of vertical pieces by their own weight muſt be counted, though not as equal to the ſame quantity of external burden laid upon them: its operation is viſible in high maſſive beams, which bend without any load; but in ſhort though ſlender pieces it is not ſufficient to break the internal coheſion of the parts. The effect of external weight is according to its quantity, and to the height and ſlimneſs of the piers; but not in uniform proportions. Divers kinds of wood have alſo different degrees of weight, and of vertical firmneſs: ſome are both ſtiff and light to an admirable degree: piers made of theſe can under ſlender forms bear weights many times greater then their own. Theſe qualities are in their blended effects of different value in this machinery: the pillars are the moſt preſſed, but they cauſe no weight to the power, and therefore their bulk is the leſs detriment. B B being the heavieſt laden piers are the moſt ſolid, but they have only a ſimple moment: C C bearing leſs are lighter, but their moment is double: D has a treble moment, but the lighteſt burden, and thus the leaſt weight of its own. Theſe continually growing increments of ſolidity are neceſſary conſequences of the conſtant double bearings; but ought to be ſmall in compariſon to the preſſures thus produced, which become very great, when the load to be lifted and the elevation are conſiderable. Lightneſs is then moſt beneficial in the upper ranks, and firmneſs in the lower, as *theſe muſt lift but thoſe be lifted* many times: accordingly different ſorts of wood may be choſen by their degrees of lightneſs and firmneſs; they being

otherwiſe

otherwise proper, especially for close and smooth folding.

On account of the grooves and tongues the pieces cannot have those regular forms that give the greatest solidity; nor can the pulleys be placed exactly over the line of central strength. In practice these defects must not exceed necessary limits. Moreover, when the pressures and strains on the several parts of the pieces are estimated, hollows may be contrived in places that can bear it—These niceties cannot be marked in a model.

When the load, the elevation, and quality of the wood are given, the lightest series of piers is found by computing the results from different numbers *. A greater number must effect a greater proportion of the whole elevation than a smaller, because the pillars, by becoming shorter, contribute less; this addition is a new expense of power. The weight of the load is essential, as it must be multiplied by the whole number of piers; imparts the same moment to its own pier of competent bulk; and in conjunction with it thickens with continual increase all the others. On the other hand the firmness of piers increases greatly with the decrease of their height within certain limits. Some species of wood have also corresponding degrees of strength. The co-operation of these advantages may therefore render a considerable number of short piers light, and proportionally so in their respective multiple moments. The more numerous the piers are, the sooner is the machine wound up, and let down, which is

* In this the pairs are considered as one.

an

an advantage, ſo far as men can make greater exertions for a ſhort time.

The form of the windlaſs determines, in combination with the preceding, the ſpeed of operation, and the degree of power. It admits various modes: for example, one might be placed on either ſide of the pillars, with long handles on the winches; by which eight men can work together. This model is intended to ſhow conſiderable effects from an eaſy apparatus: accordingly two men lift another, and three tiers of piers: they are aided by a ſufficient projection of the winches beyond the ſemidiameter of the boxes: this has ſuch proportion to the height of the pulleys in the pillars, and the equal length of the cords *a a* below them, that the whole winding is done by a few turns. The dimenſions of the piers are not ſpecified, as my experiments are not ſufficient; but I eſtimate them ſo, that the elevation is at leaſt fifty feet. The power increaſes, though the velocity decreaſes, by leſſening the width of the boxes; and this can be done while their length can ſo correſpond, that the rounds of the cords *a a* have ſufficient room, when the machine is wound up.

Oblique preſſures cannot ariſe from the principles of conſtruction; but happen from inevitable imperfection of materials and workmanſhip in a ſmall degree, which is not an object of exact calculation, but ſhould have full allowance for its effects on the machine. The obliquity will be the greater as the folding is ſhallow, and the fitting is looſe. The effect reſults jointly from the angle of declination, the length of the pier, and its moment of weight. The oblique bearings on the ends of the tongues, when the machine is

 wound

wound up, will be dangerous, if these have not a competent solidity.

All the piers with their moments of weight bear on the pillars; and the pressure on their pulleys is the difference between double the power and the strain of their heads, which balance is very great. This pressure remains there when the machine is wound up, in every stage of the elevation, however great. The common centre of gravity of the pulleys thus pressed, the pillars themselves, and the base, is below the pulleys. Thus the machine has a great stability, and the base is accordingly not extensive.

This machine combines these advantages: ready approach to heights otherwise not accessible without great trouble: speedy ascent and descent: convenient folding for keeping under cover, and for easy conveyance. It can be applied to several useful purposes:—Quick hoisting and lowering of things on many occasions; particularly saving of goods from upper stories in cases of incend: high elevation and speedy exchange of signals: these being light may be raised three hundred feet, and above interjacent hills: Elevation of a person for taking views, and quick descent when required; as on reconnoitring an enemy within shot: a machine calculated for lifting him at least one hundred feet by eight men can be light enough for carrying on a waggon by two horses.

VII.

VIII. *Description of a Machine for saving Persons from the upper Stories of a House on fire, by the Author of the preceding Paper.*

WITH A PLATE.

ABCC (fig. 4. pl. III.) is a trunk with a socket from top to bottom, and two pulleys *a*, *a*, in the sides C, C. In this the cylindrical shaft DE moves, supported on the pulleys by two ropes. These are by one end tacked to the foot of the shaft, and by the other to the axes of the windlasses I, I, which stand below. The cranks, winding the ropes round the axes, lift the foot of the shaft to the pulleys, and by unwinding let it down to the bottom.

FEG is a lever, turning on its fulcrum, which is fixed on the top of the shaft, by the iron tire *d*. The long arm is pressed by the frame at its end: the short one is held in balance by the rope GH, which is fastened on the base of the machine. As the lever descends with the shaft, the rope slackens on the short arm; then the other, no longer balanced, descends round the fulcrum, and by this motion turns the short one upwards tight against the rope. Their angular contrary movements continue thus, until the shaft reaches the bottom of the socket; and the basket at the same time comes to the ground.

The base is a rectangular plank floor with a compact frame underneath. The trunk is fixed in it, by several bracers *c*, and other usual fastenings, both above and below, standing somewhat

 from

from the centre towards the rope G H, in order to counteract its raiſing that end.

The windlaſſes are firmly ſet in the floor, near the trunk, directly under the pulleys.

The wheels are low and ſtrong, placed near the corner of the baſe. They have locks, to be uſed when the machine is loading.

The baſket is breaſt-high, and wide enough for four perſons. The three iron rods keep it more ſteady than cords would; and their openings admit one perſon at a time. It hangs free from the end of the lever.

The principles of this conſtruction ariſe from the requiſite properties of this machine: it muſt be ſpeedily brought; readily fitted; practicable in confined places; want no ſupport from the wall; reach a conſiderable height, and alſo project over obſtacles on or above the ground; take down ſeveral perſons at once, and without any exertion of theirs. The two vertical pieces folded, with the lever oblique, can both be houſed and eaſily carried: when put in action, they expand gradually; and the lever is high when at full length. The baſe may be convenient, becauſe its own weight, with the trunk and the four men at the windlaſſes keep the centre of gravity pretty low; and all the preſſures bear perpendicular on the longer face. Beſides, people may ſit down on the ſides, or hold it by handſpikes, which may be kept on it, and when wanted, put into holes near the margins, ſo as to project outwards *. A level poſition being very neceſſary, a plumb rule ſhould alſo be hung on the trunk.

* It is wider on the model than it appears under an oblique perſpective.

The

The cylindrical form of the ſhaft and ſocket procures an eaſy gliding motion, that leſſens the occaſional ſideway bearings. It is alſo leſs alterable by wear, and change of weather; it makes the ſhaft more ſolid, and thus requires leſs bulk in both pieces. The two quarters of the trunk which are ſlit for a communication of the ropes with the ſhaft, will yet be ſtrong enough by the ſolid piers that bear the pulleys. The other two have ſufficient firmneſs againſt oblique preſſures, ariſing from the action of the machine, or from the caſual inclination of the baſe. The part from the brim to the pulleys incluſively is fortified by the iron-band B B, to ſecure the ſhaft when drawn up. The height of that piece, its own weight, the preſſure on its head, and the obliquity of the ſame at the time, together with probable external accidents, will determine the width; it need perhaps not exceed a fifth of the part below.

The trunk and ſhaft require ſtiff and hard materials. The lever being made of tough wood, may be further ſtrengthened by iron plates. The ſolidity and ſhape of the fulcrum and arms muſt be carefully proportioned to their reſpective weights.

The ſhaft, when down, reaches beyond the trunk ſo much as to clear the lever of the piers. This added to the diſtance of the brim from the pulleys, is the difference between the ſhaft and their height *a a*. The altitude *a* E is therefore *a a* doubled and that ſurplus. If the ſhaft bore a greater proportion in effecting this altitude, it muſt be longer; conſequently it would, when ſtanding, hold the arm farther from the ground, and render that piece, with itſelf, leſs portable; and,

and, when up, increaſe the weight on the fulcrum, and the preſſure againſt the ſocket.

The arm E F riſes from *a* E on an angle about fifty degrees with the horizon, thus making a good projection, and a conſiderable increaſe of altitude. Its proportion to the ſhaft, and angle with it when down, are ſuch as to ſet the baſket on the ground.

Theſe angles, the ſhaft, and the ſpace *a a* (its elevation), accord in adjuſting the proportion of E G, and the poſition of the rope. When the lever deſcends, the arm E G opens, and throws out the rope, keeping it ſtretched all the while. This makes it deſcribe a circular arch. The lever having come to a horizontal poſition, the arm by the continued rotation returns towards the line *a* E, and makes the rope retrace the arch until the ſhaft is down. If the reverſed angle of the arm is then equal to to *a*EG, the rope comes to the point G from whence it went, if leſs it goes beyond. In the firſt caſe E G is the ſide of a triangle which has *a a* for its baſe and two angles equal to *a* E G; in the ſecond it is leſs than this ſide. As the elevation of E F is not above 50, its complement *a* E G (40) is greater than the angle of E F with the ſhaft, which with that ſpan would hold the arm too high from the ground. It conſequently exceeds the reverſed angle which (being oppoſite) is equal with this. Therefore the ſhort arm is leſs than the ſaid ſide, but the difference is not great.—The ſituation of the ſhaft being moſt critical in the higheſt elevation, the rope ſhould then allow the lever very moderate rotation, and thus leſſen the kicking of the weight againſt the fulcrum. Its poſition will therefore be nearly perpendicular, when the deſcent begins, that

that the arch, immediately falling, or riſing very little, may keep down the end of E G. This poſition requires a moderate elevation of E F; for if the angle D E G is too contracted, E G will project far beyond the foot of the rope, in and about its horizontal paſſage, and thus produce a detrimental obliquity. It alſo limits the fall of E F, by regulating the reverſed angle; for the nearer the point G returns to the ſhaft, the further it goes from the rope, and the more oblique is the outward draught.

The obliquity of draught admitted in this machine, appears eaſy on the model: trials may prove a greater elevation of the lever practicable. The proportion of the ſhort arm is ſufficient while the whole weight to be wound up does not exceed that of twelve perſons: for ſo much, at leaſt, four hands at the windlaſſes are competent. If the rope is drawn by hands, this arm muſt ſtill, for the ſake of convenient carriage, be much ſhorter than the other; and accidents of miſmanagement might happen, which the fixed rope prevents: it is prudent to entruſt the machine with all the powers it can exerciſe; eſpecially as it muſt be uſed on the diſmal occaſion of nocturnal incends.

In conſiderable towns the houſes differ ſo much in height, that machines of two ſizes are neceſſary. The larger ſhoud be competent for the third or fourth ſtories in the higheſt buildings, according to their dimenſions, and the practicable ſize of the three pieces; and the ſmaller for thoſe in the loweſt. As both have ſeveral degrees of elevation, they will alſo ſuit inferior ſtories reſpectively, and thus take in all the different heights. The baſket muſt aſcend ſo near beneath

 the

the window, that the perſons may, without fear, get in, and deſcend ſo low that they may get out. For the laſt arm cannot be long enough, when great altitudes demand very high ſhafts; then a rope ladder may be fixed on the baſket, and let down when the machine ſtops ten feet from the ground, if neceſſary. As the dimenſions of the lever and ſhaft of large machines demand great ſolidity, their weight will bear a conſiderable proportion of the whole that is wound up. One or two perſons the more in the baſket would proportionably leſs increaſe the whole. Their baſes will alſo be wide enough for two men at each of the four cranks. The ſmaller machines muſt ſupport the weight of four full-grown perſons, as the fire may prevent a ſecond going up. Their baſes are to be fitted for narrow alleys, and crowded places.

Much property might be ſaved from the fire by machines of a ſimilar conſtruction with this, having a capacious baſket, and capſtans inſtead of windlaſſes. The combination of perpendicular and lateral movements may alſo be applied to many other valuable purpoſes.

Perpendicular lines being dropped from the point G to the baſe, the ſquares of theſe, and the ſquares of the diſtances of their ends from the foot of the rope, are jointly equal to the ſquare of the rope. The ſquare of E G is likewiſe equal to thoſe of its ſines. When the ſhaft is drawn up, the perpendicular height of the rope differs from the joint heights of the ſhaft and pulleys by the coſine of D E G; and when the ſhaft is down, it is equal to the height of this piece, joined to the coſine of the reverſed angle. The ſines of theſe angles are equal to the diſtances between the ends of

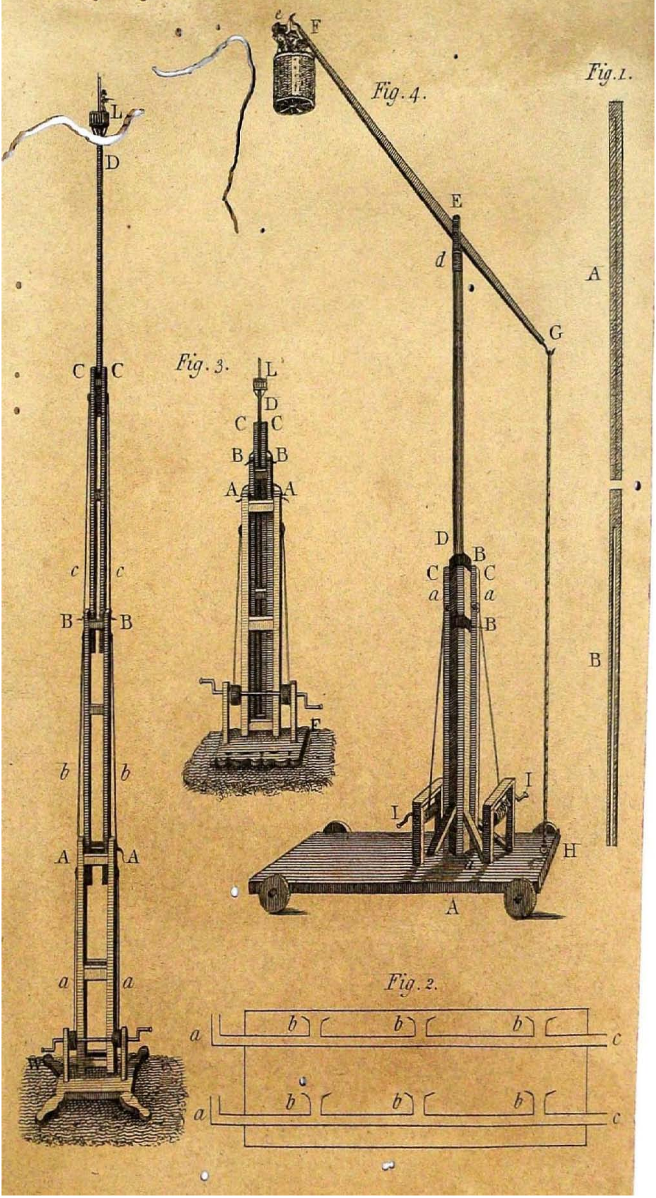

Fig. 1.
A
B
Fig. 2.
a
b
c
Fig. 3.
L
D
C C
B B
A A
E
Fig. 4.
F
e
E
d
G
D
B
C C
a a
B
I
I
H
A
L
D
C C
c c
B B
b b
A A
a a

of the ſaid perpendiculars and the centre of the trunks bottom. Taking the value of the rope in the two caſes, gives this equation: $a\,a^{2}$ + 2 ſhaft. × $a\,a$ =

$$\left.\begin{array}{l} 2\,aE \times \text{cos. DE} \\ +\,2\,ſb \times \text{cos. rev. ang.} \\ +\,2\,aH \times \text{Sin. DEG} - \text{Sin. rev. a.} \end{array}\right\} \text{EG.}$$

This will guide the choice of angles, proportion of EG, and poſition of the rope.

IX. *On the Cauſe and Cure of the Diſeaſe called the Curl in Potatoes.*

From the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

THE Society, having offered their gold medal, or thirty pounds, to the perſon who ſhould diſcover the nature and cauſe of the diſeaſe in the potatoe-plant called the *curled potatoe*, and point out an effectual cure, received the three following papers; and being deſirous of encouraging every attempt to inſure ſucceſs in the culture of that valuable vegetable, divided the pecuniary premium equally among the three candidates, Mr. William Hollins, Mr. William Pitt, and Mr. John Holt; whoſe accounts follow.

Mr. Hollin's Paper.

The curl in potatoes is a diſeaſe which admits of three different ſtages or degrees.

1st. The half-curl.
2d. The curl.
3d. The corrupted.

1st. The *half-curled* plants have leaves some-what long, and curled only in a moderate degree: they produce a tolerable crop, if the summer be not very dry; but if otherwise, the potatoes will be small and watery.

2. The *completely-curled* plants are seldom more than six or seven inches high: they soon ripen and die. The potatoes are generally smaller than a nutmeg, of a rusty red colour, and unwholesome as food.

3d. The *corrupted potatoes*, or those in which the vegetative power is nearly destroyed, never appear above ground. The seed may be found, at Michaelmas, as fresh, to appearance, as when it was set, with a few small potatoes close to it.

The first cause of the curl in potatoes must be traced to the manner in which the seed was raised the preceding year.

If the potatoes be set late in the season, that is, from the middle of May to the middle of June, in a rich soil, well manured, having a southern aspect, and if the summer should be hot and dry till (we will suppose) the beginning of August, when the blow of the plants has fallen off, then the seed will be exhausted in feeding the plant only; and very few potatoes will appear. Should the weather now become moist and genial, the plants, especially if they should be earthed, will blow afresh, and a plentiful crop of very large potatoes may yet be produced.

These potatoes are perfectly fit for use as food; but as they were produced from the stalk of the plant,

plant, after the seed itself was exhausted, they will be defective in moisture and vegetative power: and the plants which proceed from them the following year will be found to be curled.

Second Cause.

The curl may be produced without manure or earthing, provided the potatoes be sown (at the end of May) thick together, in a rich soil, and covered with green fern, or other litter, before the plants appear. The rain rots the fern or litter, and enables it to penetrate as a manure to the roots; and the plants are forced, as in the preceding experiment, to a second growth, and blow. The seed thus raised produced plants that were curled.

The forcing potatoes by cultivation, as above described, I find to be the cause of the curl, both from my own experiments, repeated for several years successively, and also from the observations I have made upon the practice and ill success of my neighbours.

It is well known that the flowers of many plants, such as the poppy, the rose, and many others, are much altered by cultivation; they become *double*, the stamina are converted into petals, the generic character is lost, they become what botanists call Monsters; the parts of generation being changed, no seed is produced. If I may be allowed to consider any part of a plant in which the vegetative power resides as a seed, it will be found that rich cultivation produces, if not absolutely the same, at least a similar imperfection in the potatoe; for the flower and the bulb-

 ous

ous root are both enlarged by cultivation. In the flower, little or no feed is produced: in the potatoe, the vegetative power is impaired or deftroyed, according to the degree of the difeafe.

It is obfervable that, wherever the vegetative power is impaired, there is always a deficiency of moifture; which confirms my opinion, mentioned before, and is itfelf proved by the following experiment.

Experiment.

Both healthy and curled plants may be raifed from the fame potatoe, in the following manner:

Dig up, in the beginning of October, fome potatoes raifed as is defcribed in the preceding pages. Amongft the largeft will be found fome that have, in different parts, different degrees of moifture, the leaft at the butt, and the moft at the crown end, the quantity of moifture gradually increafing from the butt to the crown. Take one fet from the crown, and another from the butt: the former will produce an healthy, the latter a curled plant. The curl-producing potatoes are alfo obferved to be drier both before and after boiling, and are boiled in a fhorter time.

The Mode of preventing the Curl in Potatoes.

The following directions for cultivating potatoes, duly obferved, will effectually prevent the curl; as I have found by various and repeated experiments, made with great care and attention, during thefe laft feven years.

The

The best time of setting, is from the beginning of April to the middle of May, Make ridges a yard asunder: put your manure first into the trench, and with moderation: set the potatoes in a triangular form, five or six inches asunder, cover them with the soil to the thickness of five or six inches. There is but little danger of laying on too much of the soil: the deeper are the sets, the better will they be protected from the scorching heat of the sun, if the season should be dry. This distance of five or six inches is so small as to prevent the plants growing too rank, and yet sufficient for each of them to be exposed to the sun and the air.

2dly. When they have grown to the height of six or seven inches above the ground, you must not earth them, as is the usual practice You must take away the weeds, and may draw a little mould to them; but you must be careful to do it before the blossom-buds appear, which time is generally about the end of June.

They will now require no farther care, excepting that of weeding.

I am of opinion that early setting is advantageous, on account of the greater chance of early rain, which will be very beneficial to the plants if the summer should be dry. By this process, the plants will be healthy; the young potatoes will be formed in due season; they will grow gradually; the plant will ripen and die in due time, and will not be forced into a second growth by the rain which may fall in September. The sap being thus left in the potatoe, it becomes a *seed* endued with an unimpaired perfect vegetative power; and the plants which are raised from them will be found to be entirely free from the curl.

N. B.

N. B. The potatoes may be dug as soon as they can be handled without crushing the peel, that is, about the end of September.

Sound potatoes are procured with the greatest certainty from earth that has been peeled and burnt: the soil thus prepared is well suited to the growth of potatoes. In this they grow gradually, and are not forced beyond their natural size: in doubtful seed, it is safest to plant the smallest potatoes *whole*.

The soil the most likely to produce the curl, is that which is rich in itself, much manured, and has a southern aspect. In other situations, where the soil is not rich, and the garden is cold, either from its being upon the side of a hill, or exposed to the north, the curl has not yet appeared; which is known to be the case in the mountainous parts of Radnorshire and Montgomeryshire. This is perfectly consonant with my theory; for where the soil is poor, and the situation cold, the plants cannot be forced into a second growth by earthing and manure.

I do not mean to dissuade those who are anxious to raise large crops for immediate use, from earthing and manuring to the utmost extent; I only caution them against using potatoes so raised for seed. By earthing and manuring, you will doubtless raise large crops of large potatoes perfectly good, as food, but imperfect as seed; for the vegetative power will be impaired by this forcing cultivation. Hence it will be the interest of every prudent cultivator, to allot a portion of his potatoe-garden to the raising of seed-potatoes. If the directions which I have given be followed, I have not the least doubt of success; at least I am certain that the curl will not make its appearance.

Mr.

Mr. Pitt's Paper.

Having been a grower of potatoes upon a conſiderable ſcale, for theſe ten years, I write wholly from experience: my annual growth has generally been from five hundred to one thouſand buſhels. I have frequently had a few curled, but not for ſeveral years, unleſs I planted curled ſorts in ſmall quantities, on purpoſe for obſervation. The curl in potatoes is doubtleſs owing to a degeneracy in the ſeed; to the particular ſpecies, or variety, being worn out; by too great a ſameneſs, and too long planting on the ſame ſort of land: and this degeneracy is by no means peculiar to the potatoe; every known plant, and perhaps even animal, is ſubject to a ſimilar degeneracy. Wheat, ſown too long on the ſame ſpot, without changing the ſeed, will generally become ſmut and hen-corn. I have known barley, by being ſown nine or ten years on the ſame kind of ſoil, degenerate to the lightneſs of oats; and oats, from the ſame cauſe, become little more than huſk and chaff. Peas, too long ſown without change, ripen later, and become ſo unkindly, that the pods, on the upper part of the haulm, never fill. To continue the ſame idea, and apply it in an inſtance or two to the animal creation, I have known a good breed of hogs, by repetition of breeding male and female from the ſame farrow, become ſo rickety, that they could not be reared; and have very credible accounts of the ſame effects taking place in the human ſpecies, by confining intermarriages to two or three families for generations.

I hope this digreſſion will be excuſed, as tending to illuſtrate the main ſubject, by making the cauſe of the diſorder, in queſtion, apparent.

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The cure, I have no doubt, confifts in planting forts that have hitherto retained their health and their perfection (and many fuch forts there are; frefh varieties are annually raifed, and may be multiplied almoft to infinity, by fowing the bell or natural feed of the potatoe): and indeed it is the duty, as well as intereft, of every cultivator, whether of potatoes, or any other vegetable, to procure his feed from as perfect a plant as poffible, and by no means to ufe the feed of a worn-out, degenerate plant.

I have never underftood, that the curl in potatoes has been, in this country, by any means formidable to the attentive cultivator. No one in their fenfes would plant a degenerate fort but upon a narrow fcale, nor indeed is there the leaft occafion; for the bounty of nature has always at hand plenty of fubftitutes, equal or fuperior in quality to former forts, even when they were in perfection. The varieties that I have known fail by curling, in this country, are only three: their provincial names are, firft, an early fort, called here Pretty Bettys; in lieu of which are introduced Champions and Golden Balls, both excellent early forts: fecondly and thirdly, the old Winter Reds, and Pink Eyes, have both failed, and we have inftead of them, Aylefbury Whites, the Clufter Potatoe, the Ox Noble, red and white Surinam for cattle; a dark purple kind, called by fome the Pomegranate Potatoe; and many other valuable forts, which never have yet curled. The rational remedy therefore, undoubtedly, is the raifing and introducing of frefh varieties; a practice which has never yet been interrupted by any difficulty.

5 Mr.

Mr. Holt's Paper.

On the cauſe and prevention of the curl in potatoes, I beg leave to offer the following thoughts, being a ſubject of no ſmall importance to the farmer, and to which I have paid not a little attention.

The cauſe of this diſeaſe, as far as I can judge, does not ariſe from peculiarity of ſoil, variety of manure, difference of ſeaſon (dry or moiſt): the cauſe, therefore, whatever it may be, it ſhould ſeem, originates from the ſet, which, when once infected, I imagine is incurable; and the diſeaſe or curl appears to be nothing more than a total degeneracy of the plant, by being worn out, through want of change of ſeed, upon the ſame ſoil, with probably ſome other cauſes co-operating.

It is a well-known fact, to every experienced farmer, that almoſt every ſpecies of grain and vegetables require repeated renewal, or change from different ſoils: or they wear out, (as the phraſe is), yield but imperfect crops, if continued too long; and defeat the cultivator in his expectations of reaping benefit. Why may not this too cauſe the ſame effect in potatoes, by their being too repeatedly planted, and occaſion the blaſted, early-matured appearance of the ſtems, which is always followed by a failure of crop.

In confirmation of the above theory, this diſtrict for ſome years ſuffered great injury from curled potatoes. As the diſeaſe had but then lately made its appearance, the cultivators were at a loſs for a remedy.—This was obtained by totally diſcarding their former ſeed-plants; and of late years large quantities have been annually imported from Scotland.

This practice has been attended with success: few crops, I believe, I may venture to say none, has been infected with the disease, if renewed; but if the same seed was imprudently, for a few years, continued upon the same soil, some plants would appear infected; and if still continued longer, the disease, instead of being *partial*, would soon become *total*, with few exceptions. The custom now is, to import every year from Scotland *.

There may be other reasons, which cause a degeneracy of wearing out of the plant.—Every seed has its peculiar season, when it is most proper to be committed to the earth. In some, the budding of certain plants, or the blowing of flowers, indicate this precise moment to the attentive cultivator: the month, or even the day of the month, is his only guide in others. To a few of these the most favourable time is very limited, so very limited, that the winter turnip will not (in this district) yield a crop, if its seed be not sown within a very few days before or after the 20th of July; but better, if five days before this period, than the same number of days afterwards. From the 20th of March to the end of April is a proper season for planting most of the kinds of the winter potatoe: but this root, the friend and great support of the labouring man, is not so very shy of her favours; productive crops have been obtained when planted even

* Since writing the above, I have been well informed, that the sets obtained from moss lands will make a sufficient change; and that it is universally the practice of those who live in the neighbourhood of moss lands, to procure their seed-potatoes from thence; and that this change of soil preserves them from the curl.

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in July.—Time, however, for acquiring sufficient maturity, is not allowed from such late planting; for the crop, though productive, is not perfect, being neither so solid nor palatable; and this may be one cause of accelerating a decay, or bringing on the curl.

The potatoe is also liable to other disorders: in very dry seasons, excrescences will arise, vulgarly called the scab; in moist seasons, little holes or cavities appear, called the canker; and both these disorders increase according to the length of time they remain in the earth after having acquired maturity. It is more than probable, that these disorders may hasten the decay, and cause the curl.

TO BE CONCLUDED IN OUR NEXT.

X. *Description of a Support applicable to Scale-beams, of every Size, and calculated to render the Operations, for which these Instruments are used, more expeditious and convenient, without diminishing their Accuracy.*

By R. PRONY, *of the National Institute.*

WITH A PLATE.

FROM THE *ANNALES DE CHIMIE.*

SEVERAL experiments, in which I was engaged during the course of the last winter, put me under the necessity of contriving a support, which might

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be applied promiſcuouſly to every kind of balance, whether provided with a ſuſpending handle or not, and which, without detriment to its accuracy, ſhould afford me commodious means of ſucceſſively raiſing and lowering it. It is well known how embarraſſing and laborious the operation of weighing is, when performed with balances ſupported by the hand; though this is often only the ſmalleſt inconvenience with which their uſe is attended.

Various artiſts have contrived ſupports, commodious in their uſe, and ingenious in their principle; but as each of theſe ſupports can only be adapted to a ſingle balance, they become ſo expenſive as to be out of the reach of the majority of artiſts and experimentaliſts. I think, therefore, I ſhall do them an acceptable ſervice, by publiſhing, in compliance with the requeſt of ſeveral eminent chemiſts, the deſcription of a ſupport, which, beſides the advantage of being adapted for all kinds of balances, poſſeſſes that of being conſtructed, at a ſmall expence, either in wood or metal.

It was my intention to have added to this deſcription ſome views relative to the theory and conſtruction of balances, of which I conceived that artiſts, acquainted with the elements of geometry and arithmetic, might avail themſelves for perfecting the machines uſed for weighing; but as this part of my labour has extended itſelf to a greater length than I had at firſt imagined, I ſhall publiſh it ſeparately.

A triangular foot of copper A *a*, *a*, *a*, (Figs. 1 and 2, Plate IV, repreſenting the elevation and ſection of my apparatus,) has its three extremities *a*, *a*, *a*, firmly ſcrewed down upon a table or horizontal

tal plane. Into the part A of this foot is ſcrewed a cylindrical rod A B, which may be of any arbitrary length: it may even be convenient to have two of theſe of different lengths, in order that they may be changed, when we wiſh to employ the machine for very large balances. Thoſe which I have made uſe of are, the one half a metre, and the other one metre in length.

A vertical pulley P is placed at the top of the ſtem A B, in ſuch a manner that the ſame vertical plane paſſes through the axis of the rod, and through the horizontal axis of the pulley; the block or collar C D of this pulley has at its lower part a tube C B, into which enters, with a gentle friction, the ſuperior extremity of the rod AB; a ſcrew E ſerves to keep the pulley in a fixed poſition.

Another pulley P is fixed at the bottom of the rod A B, in ſuch a poſition, that the tangent of the pulleys P and *p* is parellel with the axis of the rod A B.

A cord K *t p* H G P F, to the end of which is ſuſpended, on the outſide of the vertical table K, a ſmall weight *k*, paſſes through a hole *t* made in the foot *a*, rolls over the pullies *p* and P, and is attached at F to a piece $m\,m'\,n\,q$, which has the form of a fork, and to which are ſuſpended (as I ſhall ſhortly explain) the balance, the weights, and the ſubſtances that are to be weighed. F *m* is a button, which being ſcrewed at the top of the fork, receives the end of the cord, and by means of a knot made on it ſuſtains the fork.

The tail or handle of this fork is of a priſmatic form at the part $m'\,n$; this priſmatic part enters a groove *ff* made at the extremity N of the hori-

zontal piece N O, ſo that it can ſlide freely in this groove either upwards or downwards, its courſe being however limited at *m*[1], where it is ſtopped by the enlarged handle of the fork, and at *n* by the greater width produced by the ſeparation of the two branches of the fork.

The piece N O, which is hollow, and interſected, at O, by the ſtem A B, can ſlide along and turn round this ſtem: when it is brought to the proper height, it is ſecured by means of the ſcrew V, and it is then neceſſary, firſt, that it ſhould be at ſuch a height that, when the ſtop *m* reſts on the ſide of the groove *ff*, or when N O can move no farther down, the ſcales of the balance ſhall be in contact with the table or horizontal plane, in order that we may afterwards be able to raiſe it the whole height of *fn*; ſecondly, that the cord F F be in one and the ſame vertical plane with H G.

The groove at N ought to be ſituated in ſuch a manner that the axis of the priſmatic part of the tail of the fork, and the cord F F[1], ſhall always be in the ſame verticle plane, or in a parallel line with the axis of the ſtem A B.

Theſe diſpoſitions being made, let us imagine the two branches *n q* of the fork to be perforated with holes of different diameters, in order to receive horizontal pins (*g g*) of different ſizes; and we ſhall have all that is requiſite for the ordinary operations of weighing, performed in the air, with balances, the beams of which are ſuſpended from above.

In fact, whatever kind of balance we uſe, we are to introduce the extremity of its ſuſpending handle into the fork *nq*, and inſert into the round

round hole, which the handle of the balance always has at its superior extremity, any one of the pins that will enter with eaſe; we then apply the piece O·N, in ſuch a manner as to fulfil the conditions above laid down for the poſition of this piece; after which, it is to be fixed by the ſcrew V. This being done, the ſcales of the balance are to be charged, which being in contact with the table, or horizontal plane, can have no motion. When the ſcales are charged, we lay hold of the ſmall ball *k*, and draw the cord which ſuſpends it ſo as to raiſe the balance very ſlowly: if the ſcales be not in equilibrio, the cord is to be looſened till they reſt again upon the table, and ſo ſucceſſively.

A counterpoiſe Q, ſuſpended to the cord F G, ought to preſerve the equilibrium with the weight of the balance. By means of this precaution, it comes to paſs, that the common centre of gravity of all the forces ſupported by the pulley P falls in all caſes upon the axis of the ſtem A B, which thus has no tendency to bend.

If we wiſh now to uſe a hydroſtatic balance, we adapt to the ſtem A B a ſmall board O N, Fig. 3, which, by means of a cylindrical hole at O, may ſlide along the rod A B, and be fixed at any arbitrary height by a ſcrew at V. Another piece, or board, $K^1 K^1$ is placed upon $V^1 N^1$, in ſuch a manner that the holes T T correſpond with the centre of the ſcales, under which are placed the hooks intended for holding the ſubſtances ſuſpended in the water, and $K^1 K^1$ is fixed upon $V^1 N^1$ by means of ſcrews V^1.

Theſe arrangements being made, let the piece $N^1 O^1$, and the board $K^1 K^1$, be placed in ſuch a manner that, firſt, the whole height of the balance

lance be comprehended between this piece and board, and that the scales L L be in contact with the board K K¹, their centres corresponding with holes made in T T. Secondly, That K¹ K¹ be sufficiently elevated to enable us to place under it the vessels W W, filled with water, and conveniently to immerse, in one of these vessels, the substances which we wish to weigh hydrostatically.

According to the common practice, these substances are suspended by a very thin wire; but by placing, after my method, two vessels, and suspending to the two scales wires of equal diameter, the one of which supports the substance that is to be weighed, and the other merely in part immersed, the magnitude of the diameter will have no influence upon the accuracy of the operation; for, let us suppose the apparatus to be adjusted in such a manner, that at first the two wires were in equilibrio with each other (which may easily be obtained by varying the height of the water in the vessels), these two wires will still be in equilibrio, when the beam F F¹, being elevated, will retain its horizontal position: whence it follows, that if one of the wires have suspended to it a substance immersed in the water, and we place in the opposite scale, and consequently out of the water, a weight adequate to keep the equilibrium with the immersed substance, for a horizontal position of the beam, the equilibrium will still be maintained, whatever may be the elevation or depression of the beam, provided it continue in a horizontal position; for the lengths of the wires, either above or below the surface of the water, being equal, the difference between the specific weight of the water and that of the metal will operate equally upon both extremities of the beam.

beam. It is evident that this advanta[ge] will not be obtained if we employ only the wire [by] which the ſubſtance is ſuſpended, and that th[e] equilibrium, eſtabliſhed for a certain elevation and a horizontal poſition of the beam, will not apply to other elevations of the beam by preſerving it in the horizontal poſition.

It is to be remarked, that my method compenſates not only for the exceſs of the ſpecific weight of the wires over that of the water, but alſo for that which depends upon the adheſion of the fluid to the wires, and the covering of water which they carry along with them.

All that has been ſaid hitherto applies only to balances that are provided with ſuſpending handles; but, in order to render this ſupport abſolutely univerſal in its uſe, it was neceſſary that it ſhould be poſſible to adapt it to a beam which had nothing but its centres; for which purpoſe I contrived an apparatus, which is ſuſpended, like thoſe of a common balance, to the fork *n q*, and which may receive the centres of any beam. The engraved plates of my machine repreſent it provided with this apparatus, the conſtruction of which is as follows.

A piece *s s*' has a ſcrewed hole bored into it at *s*', into which the ſcrew *d d* is inſerted half its length. Another hole, made at *s*, in a perpendicular direction to the firſt, receives the pin *g g*, to which all the inferior apparatus is ſuſpended. This hole *s* ſupplies the place of that which is found at the upper extremity of the ſuſpending handles of balances.

Two other vertical pieces *r*, *r*, Fig. 4, have at their upper part cylindrical holes not ſcrewed, in which the ſcrew *d d* can turn freely. Theſe

ſupe[illegible] parts are placed at an arbitrary diſtance, and [illegible]tained in their ſituation by means of four nut-ſcrews *u*, *u*, *u*, *u*, each of the pieces being faſtened between two of theſe nut-ſcrews. A cylindrical rod *b b* traverſes the inferior parts of theſe pieces *r r*, and is fixed there by means of nut-ſcrews, in ſuch a manner that the ſuperior and inferior points of the pieces *r r* are invariably at the ſame diſtance.

Each of theſe pieces *r r* has, upon the ſurface which is perpendicular to the direction of *d d* and *b b*, a groove *e e*, and a circular aperture X, having at its lower part a ſmall bracket of poliſhed ſteel *a a*, intended to ſupport one of the centres of the beam. Into the upper part of the grooves *e e* a rule e^1 e^1 is introduced, which muſt enter with tightneſs, and which, with the pieces *d d* and *b b*, give ſuch a ſolidity to the apparatus, that the adjuſtment of its parts cannot be in the ſmalleſt degree deranged. The remainder of the groove, which is not occupied by e^1 e^1, ought to be of a length ſomewhat greater than that of the largeſt cock or index adapted to the beams which we ſhall have to uſe.

The method of uſing the apparatus which I have juſt deſcribed, is very ſimple. The beam which we intend to employ is placed between the two branches *r r*, which are removed from each other till the centres can be brought oppoſite to the circular holes X; the pieces *r*, *r*, are then brought together in ſuch a manner that the centres enter theſe holes X, and ſo as ſtill to leave ſome room for motion between theſe pieces and the body of the beam, in order that the oſcillations of the balance may be perfectly free. The pieces *r*, *r*, are brought parallel with each other, and

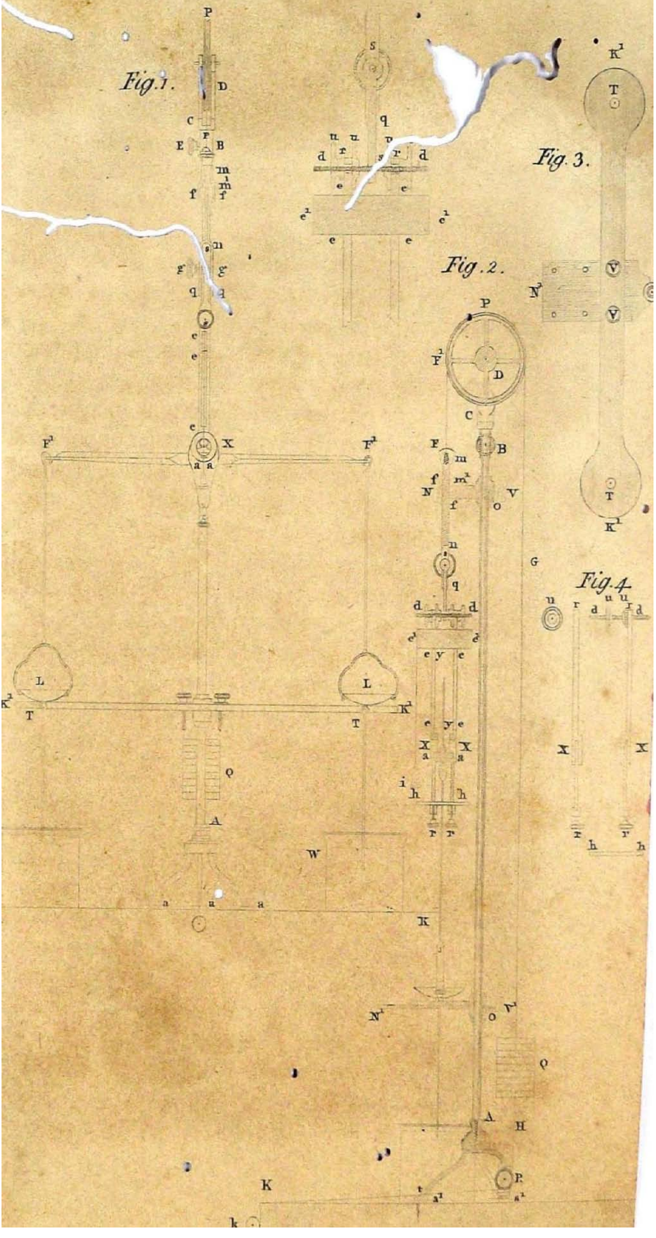
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.

and the adjuſtment of the apparatus is rendered perfectly firm, by means of nut-ſcrews, by the ſmall cylindrical rod *b b*, and by the rule *e' e'*. The apparatus being adjuſted in this manner, it is ſuſpended to the fork *n q*, by inſerting the pin *g g* into the hole *s*, and the balance is uſed in the manner that has already been explained. We know the equilibrium to be eſtabliſhed, and the beam to be horizontal, when the index *y y* divides the breadth of the ſpace *e e* into two equal parts; but, in order to aſcertain the circumſtance with greater accuracy, I have ſuſpended to the rule *e' e'* a plummet *e' i*, by means of which we may diſtinguiſh the ſlighteſt deviations of the index from the perpendicular direction.

Such is the deſcription and uſe of my ſupport, which in practice has perfectly anſwered my expectations.

XI. *On the Preparation of the Salt of Lead, or Acetite of Lead. Extracted by Citizen* VAUQUELIN, *from a Memoir of Citizen* PONTIER. *Read at the* "Conference des Mines."

FROM THE *ANNALES DE CHIMIE.*

CITIZEN Pontier begins his memoir with obſerving, that though the art of manufacturing the ſalt of lead has long been practiſed, yet we find no traces of it in works of chemiſtry, or academical collections; that thus, without doubt, a great deal of knowledge relative to this ſubject,

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of which men have been in poſſeſſion, has been loſt to us for want of having been committed to writing; and that artiſts would be ſpared much trouble, labour, and expence, if the operations of their art were deſcribed with accuracy and perſpicuity.

Though ſuch deſcriptions would, indeed, put foreign nations in poſſeſſion of the proceſſes employed in the arts, yet the length of time that muſt elapſe between the origin of an art and the period when it has arrived at ſuch a degree of perfection, that it can be accurately deſcribed, and become generally known, in foreign countries, would almoſt entirely obviate the apprehended inconveniences; beſides, that from the communication of theſe proceſſes to all the artiſts of the nation which poſſeſſes them, and from the local circumſtances frequently more favourable than elſewhere, advantages would ariſe, which would amply compenſate for any loſs thereby ſuſtained.

The author then proceeds to hiſtorical details. He remarks, that the ſalt of lead, which formerly was brought to us from Holland, where it is prepared with the vinegar of beer, is employed as a mordant for fixing alumine upon cloth, as, by means of a double affinity, it decompoſes the ſulphate of alumine, or alum; that, from a period to which he can aſſign no preciſe date, the departments of Bouches-du-Rhône and Var, have been in poſſeſſion of this art, which is principally carried on in the towns of Aix, Marſeilles, Toulon, Saint-Tropez, Draguignan, Delue, &c.

Each of theſe countries yields a quantity of wine ſufficient for ſupplying the conſumption of the inhabitants, and the manufactories of brandy,

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as well as the quantity of vinegar requi[illegible] for the preparation of the ſalt of lead.

The capitals required for manufactories of the acetite of lead are not very conſiderable; and ſince the manufactories of printed callicos have increaſed in number and importance, their produce has become pretty conſiderable, the advantage of which is entirely on the ſide of the cultivator, who is enabled to turn to profit an article for which otherwiſe he has no immediate uſe.

The lead employed in this manufacture was formerly brought to us from England, in pigs, weighing 5–6 myriagrammes; but we now uſe that of the mines of Brittany, which ſufficiently anſwers the purpoſe. The purity of the lead is a matter very eſſential to the ſucceſs of the operations, which are much impeded by the admixture of foreign metals; of this circumſtance the manufacturer is enabled to judge by the quality of the reſiduum which he obtains in his operations.

Citizen Pontier obſerves, that if the mines of lead, which exiſt in the ſouthern departments, were wrought, we might obtain this metal at a very moderate rate, and combine with the manufacture of the ſalt of lead that of white-lead, by employing the huſks of grapes, which at preſent are uſed for the preparation of verdegris. By thus employing its induſtry upon its territorial produce, a nation enhances the value of its poſſeſſions, and diffuſes plenty in diſtricts that appear to be the leaſt favoured by nature.

This object deſerves the more attention, as the ores of theſe provinces are very rich, if we may judge from the ſpecimens which Citizen Pontier has collected from the galleries that have formerly been

been c... ed, and from the reſult of labours which ... e room for the moſt ſanguine expectations.

The vinegars are prepared in places where they are more or leſs abundant, according to the nature and expoſure of the ſoil in which the vine is reared, and eſpecially in proportion to the care employed in the manufacturing of the wines.

The manufacturer buys up ſuch as are to be had within a convenient diſtance, taking care to modify the purchaſe-price according to the diſtance, in order that the charges of tranſportation may not abſorb the profits which he ought to obtain from his labour. If the quantity which he can obtain in this manner is not ſufficient for ſupplying his manufactory, he manufactures wine into vinegar for his own uſe.

The ferments which he employs for this purpoſe are the lees of wine, the reſiduum from the diſtillation of vinegar, vine-ſtalks chopped into ſmall pieces, boiling vinegar, which he pours into the tubs which contain the wine; in ſhort, all the known means whoſe ſucceſs depends upon the temperature of the place.

He preſerves the vinegar in barrels, for ſupplying the alembics in which it is ſubjected to the proceſs of diſtillation.

Earthen veſſels and boilers of maſonry cannot be employed for this purpoſe, on account of the lime and magneſia which they contain, and which would ſaturate a part of the vinegar.

The inſtruments neceſſary for the manufacture of the ſalt of lead are, 1, tubs of different ſizes, hooped with iron, and provided with wooden ſpiggots; 2, a large alembic, ſimilar to that uſed for diſtilling brandy, having a capacity of 6–8 kilolitres,

kilolitres, to which is adapted a tube of tin, which paſſes in a right line through a tub filled with water, which ſerves as a refrigeratory. Theſe alembics have two copper tubes inſerted near the bottom, for the purpoſe of drawing off the reſiduum of the diſtillation; 3, a large earthen veſſel, or jar, for containing the diſtilled vinegar, (large glaſs bottles would be preferable); 4, an iron pot, for melting the pigs of lead; 5, a copper pan, of an oval form, into which the melted lead is poured from time to time, with an iron ladle, in order to give it an extenſive ſurface, and render the plates ſufficiently thin to be eaſily cut; 6, pans of ſtone-ware, in which the plates of lead are placed, to be expoſed to the action of the vinegar; 7, two large boilers, of tinned copper, for boiling the ſolution of lead: they ought to have an equal capacity with the cucurbit of the alembic, in order that the fuel may be œconomiſed, and fewer boilings required. One of theſe boilers is uſed for evaporating the filtrated ſolution of the ſalt to the point of cryſtallization; 8, a ſtrainer, conſiſting of a wooden frame, perforated with ſeveral holes, that anſwer to the pans placed below, and covered with a clean piece of canvas; into each of the holes in the frame a piece of blotting paper is introduced, through which the liquid is filtrated; 9, finally, ſeveral ſmall inſtruments, common to almoſt all the chemical arts, and too well known to require particular mention.

Proceſs.

When the lead is almoſt entirely melted in the iron pot, it is taken out with an iron ladle, and before

before pouring it out, the ladle is reſted upon one of the extremities of the copper pan, from whence, as from a centre, it is made with the hand to deſcribe a ſemi-circular motion, from left to right. By this means the lead is made to lie flat upon the ſurface of the copper, and it is obtained in plates of the thickneſs of a millimetre, more or leſs. Theſe plates are detached by a workman with a pair of pincers, whilſt another lades a freſh quantity of lead out of the melting pot, in order to continue the operation. When a ſufficient number of theſe plates have been prepared, they are cut with a hatchet, upon a block of wood, into pieces of different ſizes, which are put into the pans of ſtone-ware. Prepared in this manner, the lead diſſolves in the vinegar much more readily than when it has been hammered, the effect of which operation is to bring its particles into cloſer contact with each other.

Two or three kilogrammes are put into each of the ſtone-ware pans, the number of which is regulated according to the quantity of vinegar which we have, and that of the acetite of lead which we intend to prepare.

To proceed to the diſtillation of the vinegar—we fill two-thirds of the cucurbit of the alembic with this liquid, and lute the jointings of the apparatus with a paſte of rye-flour and water, which is covered with ſtripes of linen or paper; after which we heat the furnace.

For this purpoſe we employ, according to the local circumſtances, either pit-coal or wood; when we uſe the latter, there is no neceſſity for a grate. It is neceſſary that the water in the recipient ſhould be renewed from time to time during the courſe of the diſtillation, leſt it ſhould acquire

quire too high a temperature: if there is a ciſtern or well in the neighbourhood of the place in which the diſtillation is carried on, it greatly facilitates this labour.

The acetous acid which paſſes over is received into veſſels of glaſs or wood; but as this acid is leſs volatile than water, the diſtillation is continued almoſt to dryneſs; otherwiſe a large quantity of it would be loſt.

Into each of the plates, upon which the lead has been placed, about a litre of this acetous acid is poured, after which they are diſpoſed upon ſhelves, one above the other, in order that, aided by the contact of the air, the oxygenation of the lead may take place. We find a white oxyde to be produced upon the ſurface of the metal that remains above the vinegar: the ſolution of this oxyde is effected by plunging the plates, upon which it has been produced, below the ſurface of the liquid, whilſt we put in their place thoſe which till then had remained immerſed. Theſe alternate changes are repeated twice or thrice a day, according to the degree of rapidity with which the plates become oxydated, the elevation of the temperature, the concentration of the acid, and the dryneſs of the atmoſphere. When, by the continued action of the vinegar, theſe plates have become thinner, and diminiſhed in bulk, new ones are added, in order that the pans may always be full.

The acetous acid gradually aſſumes a greyiſh milky colour, becauſe, in diſſolving the oxyde of lead, it at the ſame time carries away ſome metallic parts, which are detached by the friction. Experience has ſhewn, that the weaker the vinegar is, the leſs the lead whitens, and the more

 conſiderable

considerable becomes the quantity of detached metallic parts; on which account we ought to employ the ſtrongeſt vinegar that we can procure.

This liquor is poured into boilers of tinned copper, in which the combination is completed by ebullition, which, by vaporifying the humidity, condenſes the particles of the vinegar, and renders them more capable of ſaturating and diſſolving that portion of the lead which before was only ſuſpended in the liquid. The volume of this ſolution is reduced to two-thirds, and, after having been filtrated, it is put into the other boiler, and evaporated to that point, at which a ſmall quantity of the liquid, when taken out, and ſuffered to cool, affords cryſtals. It is then filtrated once more, and put into earthen pans to cryſtallize.

The reſiduum of the firſt filtration is either diſtilled in earthen pans with a freſh quantity of lead, or kept for an uſe of which we ſhall ſpeak hereafter. Twenty-four hours afterwards, when the cryſtals have properly depoſited themſelves, they are taken out, and ſuffered to dry in the ſhade; not in the ſun, as they eaſily effloreſce. This ſalt generally forms itſelf into oblong priſms, more or leſs white or yellowiſh, in proportion to the denſity of the mother-waters in which it has cryſtallized.

The mother-water is again put to cryſtallize, but as it becomes more and more exhauſted, the cryſtals acquire more of the yellow tinge; on which account the manufacturers diſtinguiſh two ſpecies of ſalt; the one, greaſy to the feel, pulverulent, apt to form into balls, and of a greater ſpecific weight; the other very white, in the form

form of fine needles, and much lighter than the former, in conſequence of its containing none of the mother-water.

After having given a clear explanation of the operations practiſed in the manufacture of the acetite of lead, in the ſouthern provinces, Citizen Pontier propoſes ſome important improvements.

In the firſt place, the frequent and expenſive repairs, which are rendered neceſſary by the damage done by the continual action of the vinegar, to the different parts of the alembic, induced him to direct an alembic to be made, with a wider orifice and lower ſides than ordinary, which he covered with a capital made of the common potter's-ware of the country. This alteration ſucceeded entirely to his wiſh.

He obſerved that the pans, which are uſed for diſſolving the lead by the vinegar, become covered, on the outſide, with a ſaline effloreſcence, formed by the combination of the vinegar with the lime and magneſia that enter into the compoſition of theſe veſſels; and that it is to the preſence of theſe ſalts, which cryſtallize with difficulty, that the mother-waters owe their conſiſtence and unctuoſity.

The ſame effect was obſerved in the capital; but after the effloreſcences had been ſucceſſively removed, as faſt as they formed, it at length came to paſs, that no more of them appeared; this was at the period when all the calcareous and magneſian particles had ceaſed to exiſt, and the ſubſtance of the capital was reduced to the ſtate of true ſtone-ware; that is to ſay, when it contained nothing more than ſilex and alumine.

Inſtead of the copper and tin worms, Citizen Pontier informs us, that we may uſe worms of wood, compoſed of ſeveral pieces, which fit into one another, and are diſpoſed in a ſpiral form, in order to favour the refrigeration and condenſation of the vapours. He has employed however, with ſtill greater advantage, tubes of ſtone ware, which he procured from Paris, and luted together with lint and clay, ſecuring the whole with pieces of elaſtic gum. The diameter of theſe tubes being double that of the ordinary worms, the vapours condenſe themſelves more eaſily in them, and, oppoſing leſs reſiſtance to the ebullition, accelerate the diſtillation, which Citizen Pontier renders ſtill more active, by cauſing the refrigerating waters to fall upon the neck of the capital itſelf. He has remarked, that, of the leaden worms, thoſe which contain the ſmalleſt quantity of tin are the moſt ſerviceable.

He next directed his improvement to another object. Obſerving that the firſt products of the diſtillation always contained, mixed with the vinegar, a ſmall quantity of alcohol, which was entirely loſt upon the preparation of the ſalt of lead, he ſeparated it, in order to diſtil it afterwards by itſelf, and extract the pure ardent ſpirit. This ſpirit was of a harſh, aſtringent, and ſomewhat bitteriſh taſte, which confined its uſe to the preparation of varniſhes.

Having extracted 15—20 myriagrammes of ſpirit from 3—800 kilolitres of vinegar, he endeavoured to render it fit for being manufactured into *liqueurs*, by means of rectification. He ſucceeded by mixing it with water, after having diſtilled it a great number of times according to the proceſs

proceſs of Kunkel. A yellowiſh ſubſtance was ſeparated, and ſwam on the ſurface in the form of an ethereal oil; it was ſeparated from the water by means of a white mucilage inſoluble both in water and alcohol.

Citizen Pontier obſerved in this ſpecies of acetous æther ſome peculiar characters, which tend to throw a light upon the theory of fermentation. He promiſes to enlarge more upon this ſubject, as ſoon as he ſhall have leiſure to beſtow more attention upon it.

The filtration and ſolution of the acetite of lead being a tedious and troubleſome operation, Citizen Pontier has omitted it, merely leaving the liquor to cool in the boiler, and pouring it off when it has cleared. This method has ſucceeded perfectly.

The depoſition formed during the evaporation was treated with a freſh quantity of vinegar, which excited a briſk efferveſcence, by diſſolving the oxydated portion: it yielded, by evaporation, cryſtals ſimilar to the firſt. There remained behind a certain quantity of a ſubſtance, which, when fuſed in the crucible with a mixture of potaſh, ſaltpetre, and charcoal-powder, yields a button of lead, in which a large quantity of ſilver is diſcovered by cupellation. It is therefore, as the author obſerves, mere waſte to throw away theſe reſidua, from which ſilver might eaſily be extracted.

The mother-waters impart to the cryſtals a yellow tinge, and augment their weight, without adding to their uſefulneſs in dying. Citizen Pontier has reduced them ſeparately with charcoal-powder, according to the method of Lowitz, and obtained a yellow ſalt, in ſhining ſcales, reſembling unc-

tuous

tuous honey, and that melt in the heat like butter.

He was not able to obtain it in prifmatic needles; but upon diffolving it in a frefh quantity of acid, it recovered its ordinary form and whitenefs.

By thefe means he exhaufts the mother-waters of all the lead which they contain in excefs: hence it is evident, that there remains in the mother-waters, the weight of which is confiderable, a quantity of lead, which is not fufficiently faturated with vinegar to be capable of forming prifmatic cryftals. Citizen Pontier has obferved the quantity of the mother-waters, and confequently of this peculiar lamellated falt, to be greater in proportion as the vinegar is weaker; and that it is on this account that the French falt of lead, which is manufactured with wine-vinegar, is at prefent preferred, for printing cloth, to that of Holland and England, which is prepared with the vinegar of beer, which is always weaker, and confequently forms more mother-water, in which there is a fmaller proportion of acid.

Citizen Pontier concludes his memoir with fome remarks on the alterations, which he propofes to be made in the manufacture of falt of lead: he juftly confiders the procefs which oxydates and diffolves at the fame time the vinegar, to be the moft economical; for, in his opinion, it would not be advantageous to diffolve directly the white oxyde of lead, both on account of its high price, and the carbonate of lime which it contains, whereby a portion of the vinegar would be faturated and loft. The fame, however, would not hold good, in cafe the lead mines which exift in the country fhould be wrought, and the metal converted into litharge

litharge on the spot: it would then be more advantageous to use it in this state.

Citizen Pontier proposes to treat, in a future memoir, of the chemical part of the art; of the causes which produce variations in the crystallization of the salt of lead; of the differences in the oxygenation of the lead with respect to the vinegar which it may contain; of those found in the acid, according to the substances which have furnished it; of the experiments which he has made relative to the oxydation of copper by means of distilled vinegar; finally, of that ethereal substance in which he has discovered various new phenomena. It is our sincere wish, that Citizen Pontier may find leisure and favourable circumstances for putting his project in execution, the result of which will undoubtedly be a very interesting work, that will give him new claims to the esteem and gratitude of the public, which he has already so well merited.

XII. *List of Patents for Inventions, &c.*

(Continued from Vol. XIV. Page 432.)

John Gamble, of Leicester-square, Middlesex; for a machine for making paper in single sheets, without seam or joinings, from one to twelve feet and upwards wide, and from one to forty-five feet and upwards in length. Dated April 20, 1801.

Thomas Binns, of Great Barlow-street, Middlesex; for a method of manufacturing candles of

of spermaceti, tallow, or any other solid inflammable substance. Dated April 23, 1801.

THOMAS WRIGHT, of Mark-lane, in the city of London, Broker; for an improved method of making hand-stone corn mills, for the purpose of grinding wheat and other grain into flour. Dated April 25, 1801.

WILLIAM BICKNELL, of St. George's parish, Hanover-square, Middlesex, Hosier; for a method of covering felt for the making of caps and helmets, and for various other useful purposes. Dated April 28, 1801.

RUDOLPH ACKERMANN, of the Strand, Middlesex, Printseller, and PETER JAMES CUTTEAU, of Bucklesbury, in the city of London, Merchant; for an improved method of rendering all sorts of woollen cloths, cotton, linen, silk hats, paper, and other manufactures and substances, perfectly water-proof, and so as to be used on all occasions where a power of repelling rain, wet, or moisture, may be required. Dated April 28, 1801.

GEORGE WARING, of Buntingford, Herts; for a method of making soap of a peculiar quality. Dated April 28, 1801.

RICHARD WILCOX, of the city of Bristol, Engineer; for improvements upon the fire or steam engine and furnace. Dated April 30, 1801.

WILLIAM WILSON, of the city of Edinburgh, Smith; for an improved plan of making, adjusting, and stamping, scale weights. Dated April 30, 1800.

Printed by NICHOLS and SON, Red-Lion-Passage, Fleet-Street, London.

REPERTORY OF ARTS AND MANUFACTURES.

NUMBER LXXXVI.

Printed by NICHOLS and SON, Red-Lion-Paſſage, Fleet-Street, London.

XIII. *Specification of the Patent granted to* MR. THOMAS BINNS, *of Great Barlow-ſtreet, in the Pariſh of Saint Mary-le-bone, in the County of Middleſex, Water-Cloſet-maker; for his Invention of a Machine or Apparatus, anſwering the ſeveral Purpoſes of a Portable Water-Cloſet, a Bidet, and eaſy Chair, which together are compriſed in one-third of the Space or Room occupied by Portable Water-Cloſets now in Uſe; and which, from its Lightneſs and Size, is particularly calculated for travelling or for Camps and Ships.*

Dated November 4, 1800.

WITH A PLATE.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that I the ſaid Thomas Binns, in compliance with the ſaid proviſo, do hereby deſcribe and aſcertain the nature of my ſaid invention, in manner following: that is to ſay: The object of my invention is, to remove the complaint made againſt a portable water-cloſet (heretofore

tofore invented and manufactured by me), on account of its being too bulky for frequent removals, and to increase the utility of these machines, by the addition of a bidet-pan. In my former portable-closets, the back, enclosing the water cistern, was vertically fixed upon the seat or lower part of the case *; in my present invention, the back shuts down upon the seat in the manner of a lid, and thus not only reduces its size to one-third of the dimensions of the former ones, but also renders it more convenient for travelling, and less liable to be injured. This important advantage of folding down the back of the closet upon the seat, I obtain by different means, *viz.*

First, By a screw-jointed tube, as particularly delineated in Figs. 6 and 7, (see Plate V.) This tube consists of two angular parts, made of brass or any other proper materials, the end of one part is inserted and secured in the bottom of the water cistern, and the end of the other part is attached to the basin, in the common way of manufacture. The two parts of the tube are firmly connected, by the one screwing into the other, as may be seen in the above-mentioned figures, and serve at the same time as a joint for the back to turn upon, in being folded down upon the seat. When the back of the closet is raised, the screw of the tube is perfectly close or home, the extremity of the female screw pressing against a small collar of leather which surrounds the shoulders of the male screw; but when the back is folded down upon the seat, the screw, as being the joint or hinge, relaxes a quarter turn.

* See the specification in our seventh volume, page 234.

Secondly,

Secondly, By a jointed tube varying from the above, only in being a cock joint inſtead of a ſcrew, as deſcribed in Fig. 7.

Thirdly, By a ſliding-jointed tube of two parts, each forming a curve of a quarter of a circle, as repreſented in Fig. 5, where the back of the cloſet is ſhewn in the progreſs of being ſhut down upon the ſeat, to exhibit more clearly the manner in which the tube acts. The two parts of the tube are joined to the ciſtern and baſin as the preceding ones, but not ſo advantageouſly, for this tube cannot act as a joint or hinge, and requires an accuracy in the manufacture. The above three jointed tubes are applicable to many kinds of machinery.

Fourthly, By a leather or other flexible or jointed tube, attached to the bottom of the water ciſtern and to the ſide of the baſin. The object of my invention may alſo be obtained, by varying and differently combining the ſeveral means herein-before deſcribed; but I prefer the firſt or ſcrew jointed tube, which includes more advantages than can be derived from any of the other methods. Theſe tubes I generally manufacture in braſs, or in what is known by the name of cock-metal. The manner in which the bidet-pan is added to the cloſet, is ſo ſimple and obvious, as ſcarcely to require any other explanation than a reference to Figs. 3, 4, and 8. The rim at each end of the bidet-pan reſts on the front and back edge of the ſeat of the cloſet, immediately over the baſin, and is ſupplied with water from the cloſet ciſtern, either by a ſeparate aqueduct from the ciſtern, or by the ſame channel through which the water is admitted into the cloſet baſin, and for this purpoſe an aperture is made in the

 upper

upper part of the back end of the bidet-pan, sufficiently large to admit the fan of the pan leading into the basin. The latter method I deem the best. The pans I usually manufacture in copper, and japan them; but they may be made of other materials, though none are, in my opinion, so well adapted to the purpose as japanned copper.

In the figures which are annexed to elucidate this specification, I have exhibited and described the whole closet, which contains many parts that are not new, and cannot be considered as included in my present patent. The parts which I claim as my invention, and for which the patent is granted, are the folding down of the back of the closet upon the seat, or by having the back to engage and disengage, whereby the back may be laid down on the seat, or by folding or laying down the back of the closet upon the seat in any manner whatsoever; but more particularly by the different means herein-before described; the screw-jointed tube; the cock-jointed tube; the sliding tube; the tube made of leather or any other flexible material; the application of the bidet-pan to the water-closet, and the arms or handles to make it serve as an easy chair. These arms or handles are in two parts joined by a screw near the angle; and one part of the arm, when joined or screwed together, is attached or fixed to the seat of the closet, and the other to the back by means of sliding fastenings; by which means these arms are made to engage and disengage, for the different purposes the closet may be used for; and also for the convenience of packing in the internal part of the closet in travelling. All this I claim the exclusive right to exercise and manufacture, in all the varieties of form and materials,

rials, in which they can be produced for my own benefit during the term of my patent.

EXPLANATION OF THE FIGURES IN PLATE V.

Fig. 1. A side view of the water-closet with the back shut down.

Fig. 2. A side view of the closet, with the back raised and secured by two brass arms which slide into the back and seat: for conveniency in packing these arms separate at the angle or elbow. On this side of the bottom of the closet is shewn the door which is opened whenever the soil pan is removed.

Fig. 3. The same view on an enlarged scale. The side of the case is omitted for the purpose of exhibiting the mechanism.

a. The frame or case containing the mechanism.

b. The water-cistern in the back of the closet.

c. The lever which raises the valve *f*, for the purpose of admitting water through the jointed tube into the basin or bidet-pan. This lever is raised either by drawing up the handle *d*, on the seat, or by pressing the thumb on the extremity of the lever, as appears more plainly at *c*, in Fig. 4. In doing the former, not only water is admitted into the basin or bidet, but also the water in the basin is at the same time discharged into the soil-pan below, by means of the tumbler *e*, which opens a valve at the bottom of the basin; but a pressure on the lever at the top of the back produces only a single motion for discharging water out of the cistern.

g. The screw-jointed tube more particularly described in Figs. 6 and 7.

h. The

b. The bidet-pan which rests at each end upon the edge of the seat over the basin. See also Figs. 4 and 8.

i. The closet basin.

j. The water-pipe.

k. The stench-trap.

l. The soil-pan which contains the foul water, &c. discharged from the basin. The mouth of this pan is closely attached to the pipe at the bottom of the trap, by the angular lever *m*, which is raised and secured by the brass spring catch *n*. When the pan is to be removed, a slight pressure on the knob of the catch disengages the lever, and the pan which is supported by it. In drawing out the soil-pan to discharge its contents, a lid is secured on the mouth of it to prevent the escape of any offensive effluvia in the removal.

o. The fan at the end of the pipe or tube for admitting water into the basin and bidet-pan.

p. The top of the back is a lid, which is opened whenever the cistern is supplied with water. The other parts of the figure are either too obvious or too well known to require explanation.

Fig. 4. A view of the seat of the closet, and of the top of the back when the lid is open.

q. The aperture through which the water is poured into the cistern.

r. The spring of the lever *c*.

s. The brass plate affixed to the lower part of the screw-jointed tube, and which is secured to the seat by four screws as a joint. The other references are explained by the same letters in Fig. 3.

Fig. 5. A section of the sliding curved tube.

a. The lower or external part of the tube, which is attached to the basin.

b. The

b. The upper or internal part of the tube, inserted in the bottom of the ciſtern.

c. Theſe lines delineate the bottom and front ſide of the water-ciſtern.

d. An outline of the fore-part of the back, and of the ſeat of the cloſet.

e. The joint which connects the back of the cloſet with the ſeat.

f. A collar of leather, againſt which the ſhoulder of the upper part of the tube and the extremity of the lower one preſs, when the tube is cloſed by the back of the cloſet being erect.

g. The valve in the upper or internal part of the tube, for retaining the water in the ciſtern.

h. The leather lining to the valve.

i. The ſcrew nut which binds the leather to the valve.

j. A wire to regulate the valve in its motions. In the upper part of this wire is affixed another, which communicates to the lever at the top of the water-ciſtern.

k. A fixed bar in which the regulator of the valve moves.

Fig. 6. A vertical ſection of the ſcrew-jointed tube.

l. A braſs plate affixed to the lower part of the tube, and which is ſcrewed down upon the ſeat, as appears in Fig. 4. The other references are explained by thoſe of the preceding figure.

N. B. This ſection is not in a direct line, but a combination of three, as ſhewn by the tranſverſe dotted lines in the following figure.

Fig. 7. A horizontal ſection of the ſcrew or cock-jointed tube.

m. The vertical dotted lines point out the variation, in connecting the two parts of the tube by

a cock-joint inftead of a fcrew. The other references are explained by thofe in Figs. 5 and 6.

In this fection the upper part of the tube is more highly coloured than the lower one, for the purpofe of delineating more obvioufly the outline of the two parts.

Fig. 8. A vertical view of the back part of the bidet-pan when fixed, as in Fig. 4.

1. The upper part of the edge of the feat of the clofet above the bidet-pan.

2. The rim of the end of the bidet-pan refting on the edge of the feat, which for that purpofe is bevilled from the dotted line upwards.

3. The water-pipe or tube at the back of the fan.

4. The fan which difperfes the water from all parts of its curvature; an improvement by which the bottom as well as the fides are completely wafhed.

5. The edges of the aperture in the back part of the bidet-pan, for admitting the fan. Thefe edges of the aperture clofely join to the internal furface of the bafin, and thus include the whole of the fan in the bidet-pan, when it is placed upon the feat of the clofet, as reprefented in Fig. 4.

Fig. 1.

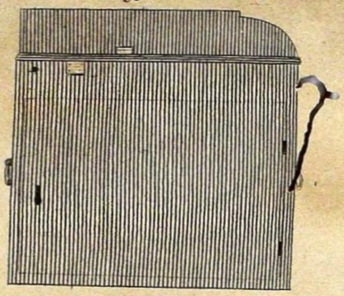


Fig. 2.

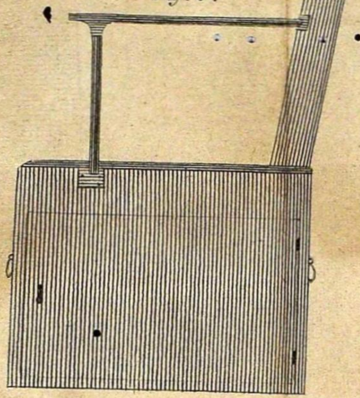


Fig. 4.

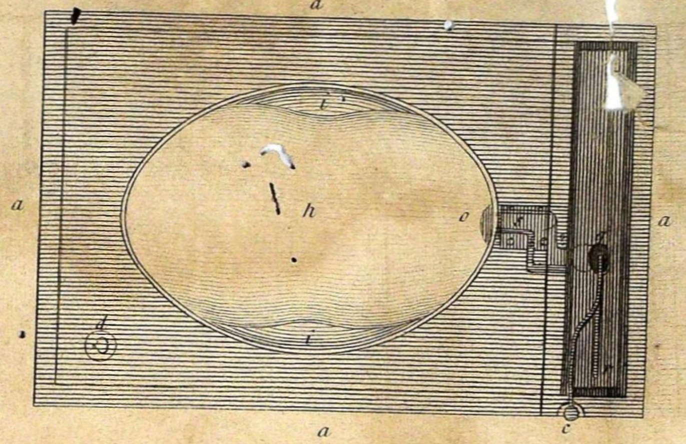


Fig. 5.

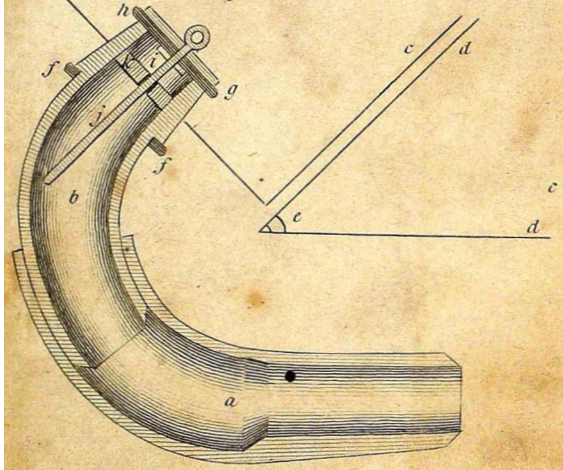


Fig. 6.

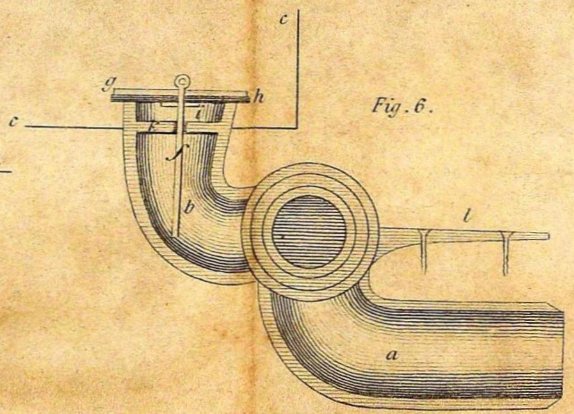


Fig. 3.

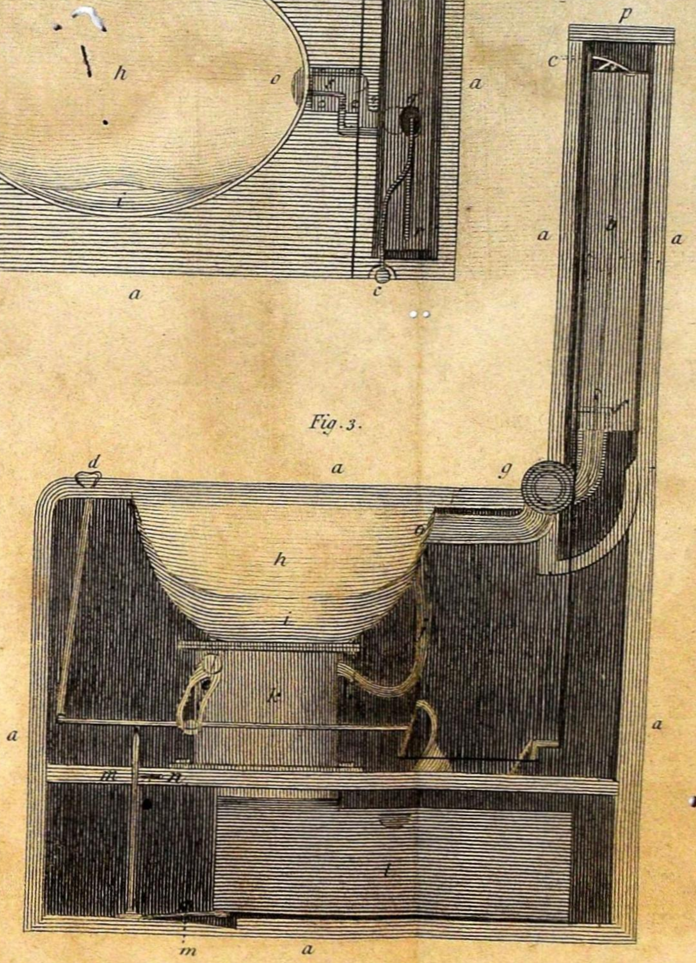


Fig. 7.

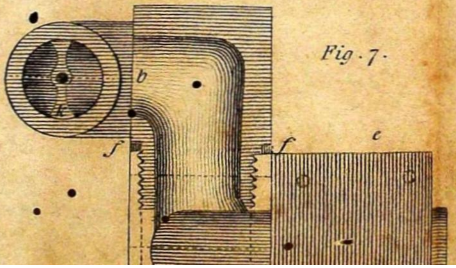


Fig. 8.

XIV. *Specification of the Patent granted to* LAWSON HUDLESTON, *of Shaftesbury, in the County of Dorset, Esquire; for a Method of conveying Boats or Barges from a higher Level to a lower, and* vice versâ, *on Canals, by the Immersion of a Plunger or Plungers.*

Dated December 30, 1800.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said Lawson Hudleston, in compliance with the said proviso, do hereby declare that the nature of my said invention, and the manner in which the same is to be performed, is described as herein-after followeth, *viz.* I assume and propose, that in order to put in practice such my method of conveying boats or barges from a higher level to a lower, and *vice versâ*, on canals, by the immersion of a plunger or plungers, there shall be or be supposed a lock (constructed of the usual and proper materials, with which locks on canals are usually or may be conveniently made to contain water) of a proper form and dimension, placed in a line between, and connecting together the upper and lower parts of a canal and navigation, and furnished at each end with a gate or sluice, sufficiently wide to allow, when opened, the passage of the boat or vessel about to be conveyed; such gates or sluices to be adapted in their respective depths, the one to the upper, the other to the lower level of the canal or navigation; the upper part or coping of such lock must be made of a height sufficient to contain the water of the upper line, and the bottom of such lock must be of a depth to correspond with that of the lower line of navigation.

navigation. The horizontal ſuperficies or form of the boat or barge intended to be conveyed, ought to correſpond with that of the lock, with the allowance of ſufficient ſpace for the free riſe and fall of the veſſel, within the ſides and bounds of the lock, the depth of ſuch boat being neceſſarily regulated by that of the navigation.

I next propoſe that there be a reſervoir building, or excavation made, (and prepared with ſtone, brick, wood, or any other proper material capable of containing water), the upper part or coping of which ſhould be level with that of the ſaid lock; and that the area of the ſaid reſervoir ſhould be equal to (or rather in practice ſomewhat exceeding) the area of the ſaid lock. In this caſe the perpendicular depth of the reſervoir ſhould be equal to double the intended riſe or fall of the veſſel within the lock; but where the areas of the lock and reſervoir are unequal, this proportion varies: for as in all caſes the quantity of water to be diſplaced out of the reſervoir into the lock, muſt be equal in cubical content to that of the ſpace in the ſaid lock, between the ſurface of the lower line and that of the upper, it follows, that if the area of the reſervoir be greater than that of the lock, the neceſſary depth of the water to be diſplaced will be ſo much the leſs than in the caſe before ſtated; and, *e contra*, if the area of the reſervoir be leſs than that of the lock, the neceſſary depth of water to be diſplaced will be ſo much the greater: ſo that whether this proportional quantity of water ſhall be obtained by the greater depth or the greater area of the reſervoir, is a point for the conſideration of the artiſt. A communication ſufficient for the free paſſage of water at or near the bottoms, or in the lower parts

parts of ſuch lock and reſervoir, is in all caſes eſſentially neceſſary. The diſtance between the ſaid lock and reſervoir or reſervoirs (where more than one) is diſcretional, provided there be ſuch level and communication: the ſhape of the reſervoir is alſo diſcretional, though for the better adaptation of the plunger or plungers hereafter to be deſcribed, I regard an angular form as the moſt convenient; and to obviate the poſſibility of damage or obſtruction to the free motion of the plunger, by the falling of ſtones or other ſubſtances, between the ſides of the reſervoir and plunger, it may be practically expedient to give to the plunger or plungers a ſhape ſomewhat diminiſhing downwards, in the nature of a reverſed pyramid, in order to enable them on aſcending to clear themſelves from the obſtructing ſubſtance.

Aſſuming the ſaid lock and reſervoir to be formed to communicate as aforeſaid, and to be ſupplied with water from the lower line, whence of courſe it would follow, that whatever may be the depth of the reſervoir, the water contained in it, and the water in the lock, and of ſuch lower line, would have one common level: ſuppoſing a veſſel floated into ſuch lock, the lower gate or ſluice ſhut, and that ſome ſolid body or bodies, equal or nearly ſo in cubical content to that of the reſervoir itſelf, be plunged downwards (whether falling by ſuperior ſpecific gravity to that of water, or forced by mechanical means) to the lower part or bottom of ſuch reſervoir, it is obvious that the water (if not all at leaſt nearly all) in ſuch reſervoir would be diſplaced, and by paſſing into the lock would, in addition to the water therein-before contained, fill or nearly fill the ſaid lock; and the ſmall quantity of water re-

maining in the ſaid reſervoir would ſurround the immerſed body or bodies up to a level with the water in the lock; and if ſuch ſolid body or bodies were withdrawn from ſuch reſervoir, then the water in the lock would ſubſide to its original level, reoccupying the ſpace in the reſervoir, lately held by the body or bodies now raiſed and before immerſed, which I call a plunger or plungers.

My ſaid invention therefore conſiſts in the practical application of the two following laws of Hydroſtatics, for the purpoſes of conveying boats or barges from a higher level to a lower, and *vice verſâ*. 1ſt, That two columns of water, however different in lateral dimenſions, will, if there be a communication between them, always maintain one and the ſame level: and 2dly, That the immerſion of any ſolid body in water will diſplace a portion of the fluid, equal in quantity to the bulk or ſolid contents of the body immerſed.—And to obviate any objection reſpecting the above application of the term *ſolid*, I beg to be underſtood as uſing it hypothetically only; being well aware, that in order to produce the propoſed effect by immerſion, it is not neceſſary that the body immerſed ſhould be a ſolid one.

Therefore I apply to the reſervoir above predicated (and to more reſervoirs than one where neceſſary, and in any poſition relative to the lock, ſo as the lock and reſervoirs have ſuch levels, capacities, convenient forms, and communications, as above deſcribed) one or more plunger or plungers, fitted to and nearly filling ſuch reſervoir or reſervoirs, and freely moving up and down therein, (but not water-tight, or acting as piſtons or forcers in the common acceptation of thoſe terms), formed of ſuch materials, be they ſtone, wood, brick,

brick, copper, iron, or any other ſuitable material or combination of materials, as may be moſt conveniently applied to and uſed in ſuch reſervoir or reſervoirs. The means of raiſing or depreſſing ſuch plunger or plungers, whether by levers, balancing-weight, ropes, chains, pullies, tooth and pinion, wheel, capſtan, windlaſs, winch, crank, ſcrew, animal force, ſteam, or other engine or engines, or other mechanical or ſtatical contrivances, muſt according to ſituations, circumſtances, and expediency, be left to the choice of the perſon or perſons applying ſuch plunger or plungers.

The ſaid invention may alſo be executed by cauſing one or more ſuch plunger or plungers, in reſpect to height and ſolid content, to deſcend or riſe within the area of a lock capable of containing, with the allowance of free motion up and down, both the propoſed boat or veſſel, and the propoſed plunger or plungers, and of a depth or depths adapted in its ſeveral parts to the neceſſary riſe and fall of each of them reſpectively, ſuch plunger or plungers being underſtood to be alſo of ſuch a figure or figures, as to permit the ſaid boat or veſſel to aſcend and deſcend freely within the ſaid lock, and along-ſide of ſuch plunger or plungers: but conſidering as I do at preſent a partition between the plunger and the lock as more eligible, I notice ſuch an application of my ſaid method principally with a view to prevent evaſion.

My preſent model conſiſts of a lock and boat as already deſcribed, (ſaving a certain exceſs in the depth of each of them), a reſervoir near to and parallel with ſuch lock, oblong and rectangular, a ſub-communication as ſpecified, a ſingle plunger,

plunger, oblong and rectangular, fitting, and subject to free motion, filling such reservoir, having two large guiding-wheels or pullies raised by two other corresponding wheels secured upon a windlass or axis, by means of lines representing chains fastened to such windlass-wheels, and passing under and round the said plunger-wheels, the ends of such lines or chains being brought up and fastened to a beam and frame, supported on the space or partition dividing the reservoir and lock; which frame and the upper part of the windlass-wheels have an elevation sufficient to allow of the ascent of the plunger, till raised above the surface-water of the reservoir. The plunger is counterbalanced by a weight suspended by a line, representing a rope or chain, fixed to the extremity of a curved or spiral lever, (as I term it, though perhaps not with strict propriety, it being analogous to the fusee of a time-piece), which lever proceeds from the windlass-axis; so that whilst the plunger is raising from its lowest depth to its greatest height, (*viz.* to the surface of the water), the said curved lever, by removing the balance-weight from the axis of the windlass, in a ratio corresponding with, or counteracting, the increasing weight of the plunger, facilitates and promotes the steady raising of the plunger; and when the plunger is to be depressed, by reversing the action of the windlass, the weight is made to approach the axis of the windlass, and following the curve of the lever, it surrenders its counteracting powers in proportion, or nearly so, to the increase of the action of the displaced water upon the lower surface of the plunger, as depressed into the reservoir.

Premising

Premiſing that I conſider my ſaid method as preferably applicable, where the lifts or deſcents are ſmall or moderate, yet without ſuggeſting precise limits, which practice only can regulate; premiſing alſo, that boats of a moderate ſize, as recommended by Dr. Anderſon and Mr. Fulton, and exceeding rather in depth than in length or breadth, ſeem beſt adapted to the mode of conveyance, the conveying of boats or barges is effected by this invention.

Let us ſuppoſe the reſervoir to be 16 feet deep, and by means of the communication with the water in the lock and lower canal to be half full of water; let us ſuppoſe the plunger to be raiſed to its greateſt height of ſuſpenſion, and to be at or above the ſurface of the water in the reſervoir; let a boat or barge be floated through the lower ſluice or gate into the lock, the lower ſluice or gate being cloſed, and the upper one remaining ſo; let the plunger be depreſſed to the bottom of the reſervoir; the water in the reſervoir (minus the ſmall quantity encompaſſing the plunger) is diſplaced into the lock through the paſſage of ſub-communication, and the ſurface of the water in the lock is raiſed as much as the plunger ſinks, *viz.* eight feet, which brings the water in the lock on a level with the upper line of navigation. The upper gate or ſluice may then be opened, and the boat floated out of the lock into the upper canal or line of navigation. For deſcending conveyance, the lock gates, plunger, and reſervoir, remaining or being put into the preſent ſuppoſed ſtate, let a boat or barge be floated into the lock from the upper canal or line, the upper gate or ſluice be cloſed, and the plunger raiſed, the water in the lock will fall as the water in the reſervoir

takes

takes place of the plunger; and when the plunger is wholly raiſed, the veſſel in the lock will have deſcended as many feet, *viz.* 8, as the plunger has aſcended, and the boat or barge being lowered to the water-level, or nearly ſo, of the lower line of navigation or canal, is ready to proceed along ſuch lower line, on the opening of the lower gate or ſluice. The lock remains in a ſituation to receive another veſſel from the lower line to be raiſed to the upper line in the courſe already deſcribed. It may be proper to obſerve, that in all caſes it is neceſſary that the height of the reſervoir ſhould be at leaſt equal to that of the lock, and that the plunger or plungers ſhould fill or nearly fill the reſervoir or reſervoirs.

This method of conveying boats or barges from line to line, whenever it is expedient to be practiſed, ſeems, on a compariſon with other contrivances of a late invention, to be attended with the following material advantages.

1ſt, The only machinery eſſentially neceſſary (the two ſluices excepted) is, for the purpoſe of raiſing and depreſſing the plunger or plungers.

2d, Whilſt the machinery in other contrivances above alluded to, is either wholly or in part liable to injury from water, the machinery in this (the two ſluices excepted) is wholly exempt from that diſadvantage.

3d, Whilſt in the other contrivances, caiſſoons, coffers, &c require not only the opening of one or more ſluices, but alſo an adjuſtment of their ends to the mouth of the canal, to prevent the loſs of water, before each boat can enter the lock; according to this plan, on the opening of a ſingle ſluice, the boat floats at once into the lock without loſs of water, and without any ſuch delay or difficulty.

difficulty. When I ſay without loſs of water, it muſt be underſtood, with this allowance, that if a boat goes down laden, and returns (or another goes up) unladen, the upper level gains a body of water equal to the weight of the cargo; *e contra*, the lower canal gains ſimilarly, if a boat goes down unladen and returns laden.

4th, By the application of this method to the common gate-lock, or by forming the lock of this invention, for the eſcape of water from the higher level into the lock, and from the lock into the lower level, the properties and uſes of the common gate-lock and of this invention are united, and they may be uſed either in combination with other contrivances, or independently. So that

5th, Whenever the water of the upper line is in plenty, ſufficient to allow of the tranſmiſſion of a lock full of water to the lower level, the machinery of this invention may be left at reſt, and veſſels may paſs and repaſs by the operation of the common lock: whereas in the other inventions alluded to, no boat or veſſel can paſs or repaſs without working the machinery, though the water be ever ſo abundant.

6th, On the ſuppoſition that the lock uſed in this invention, is conſtructed as the common gate lock for the tranſmiſſion of water, this farther and important advantage ariſes, *viz.* that ſhould the machinery of the plunger or plungers be at any time diſordered, boats may ſtill paſs and repaſs as through the common gate lock; whereas, ſhould any accident embarraſs the machinery of the other locks already alluded to, the whole navigation is obſtructed.

In witneſs whereof, &c.

XV. *Specification of the Patent granted to Mr.* James Weldon, *of the City of Lichfield, and County of the ſame; for his Improvements on a Machine or Mill for grinding Bark, and various other Articles, and for which he obtained former Letters Patent in January, One Thouſand Seven Hundred and Ninety-eight* *.

Dated February 17, 1801.

WITH A PLATE.

To all to whom theſe preſents ſhall come, &c. Now know ye, that in compliance with the ſaid proviſo, I the ſaid James Weldon do hereby declare my invention of certain new improvements on my ſaid machine or mill, for grinding bark for tanners, that the ſame improvements extend to all kinds of cylindrical or ſteel mills, for the purpoſe of grinding wheat, malt, or any other kind of grain, and may be applied to various other uſeful purpoſes. I deſcribe the ſame as follows: My former method of conſtructing mills for grinding bark is chiefly of caſt-iron, the teeth or cutters thereof caſt with them; and the method of keeping them ſharp, or renewing their teeth, is to chip or cut them with a hammer and chiſſel; and the method of making and conſtructing what are commonly called ſteel-mills, for the purpoſe of grinding malt, &c. are chiefly made of malleable iron caſe-hardened, the teeth of which are cut or raiſed out of the ſolid by means of chiſſels

* Publiſhed in our tenth volume, page 77.

and

and files, and are kept ſharp by the ſame method. But in order to avoid theſe difficulties, and make them (the teeth) more durable and laſting, and that the uſer of ſuch mills or machines may be able to ſharpen his own mill or machine, and keep the ſame in repair without ſending them to the maker, I have conſtructed them with looſe or moveable teeth, which may be taken out at any time, and by grinding them on a common grinding-ſtone, may be ſharpened and kept in order, or by replacing the teeth ſhould they wear out, the machine will then be as good as new: and to ſhew the nature of my invention, I have added drawings on the oppoſite ſide hereof, but as the principle of the machine or mill for grinding bark is the ſame as that of my former patent, it is not neceſſary to deſcribe any more of it than the manner in which the looſe teeth are to be fixed, which may be the ſame as that deſcribed in the drawing for a corn mill, or by any other method I may think moſt proper. Fig. 1. (Plate VI.) repreſents the different parts of a mill for grinding bark, corn, &c. and the manner in which it is conſtructed. A, is a hopper made of wood, tin, or ſheet-iron, which receives the corn or any thing that is to be ground. B, is the axis of the ball or inner part of the mill, which may be made of wrought or caſt iron. C, is a conical covering, which prevents the materials, to be ground, from lodging on the cap, which may be made of wood, tin, or ſheet-iron. D D, is a looſe cap, which faſtens and ſecures the looſe teeth of the ball or inner part of the mill, by means of four ſcrews repreſented by *b*. E, repreſents one ſide of the ball or inner part of the mill filled with teeth.

G, ſhews one half of the inner part of the mill without teeth, wherein may be ſeen the manner in which the teeth are kept in their places. *d d*, ſhews the ſubſtance of the metal, which is of caſt-iron. H H, ſhews the bottom flanch that holds the teeth, and is caſt with the body part of the cone. *a a a*, ſhews the outer cylinder, which is caſt altogether, and ſhews in what manner the looſe teeth, F, F, are fixed in it. I I, is a flanch which faſtens or holds the looſe teeth of the outer part of the mill by means of ſix ſcrews, as ſhewn by fig. 3. K K, is the bridge which carries the inner part of the mill, and is faſtened to the outer cylinder by means of two ſcrews, *c, c*. L, is the lower part of the axis. M, the braſs ſtep on which the axis works. N, is a plate in which the regulating ſcrew works, and is made of wrought iron. O, the regulating ſcrew. Fig. 2, repreſents the under ſide of the outer cylinder, with the bridge K, and the box which contains the braſs ſtep M. Fig. 4, repreſents one of the looſe teeth on the outer part of the mill. Fig. 5, repreſents one of the teeth on the inner part of the mill: theſe teeth may be made of caſt-iron, wrought-iron, or ſteel, or any metal or materials that may be thought moſt proper. Theſe mills or machines are not confined to any preciſe forms or ſhape, and may be made of any metal or materials I may think moſt ſuitable. They may be worked either as hand-mills or horſe-mills, or by any other power that can be applied to them. In witneſs whereof, &c.

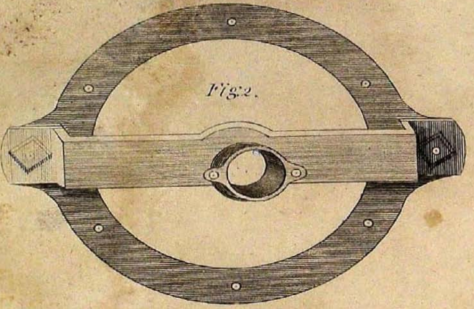


Fig:2.

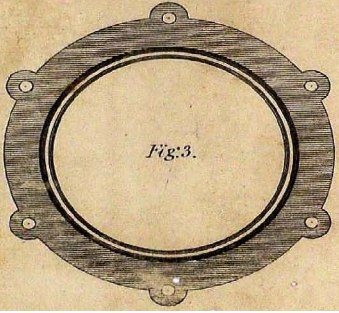


Fig:3.

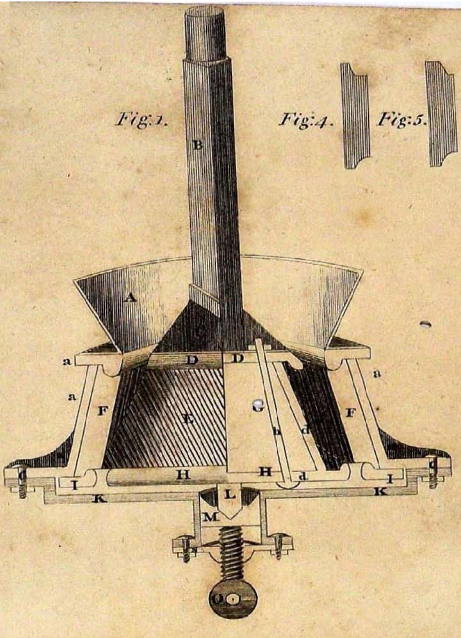


Fig:1.

Fig:4.

Fig:5.

Fig. 4.

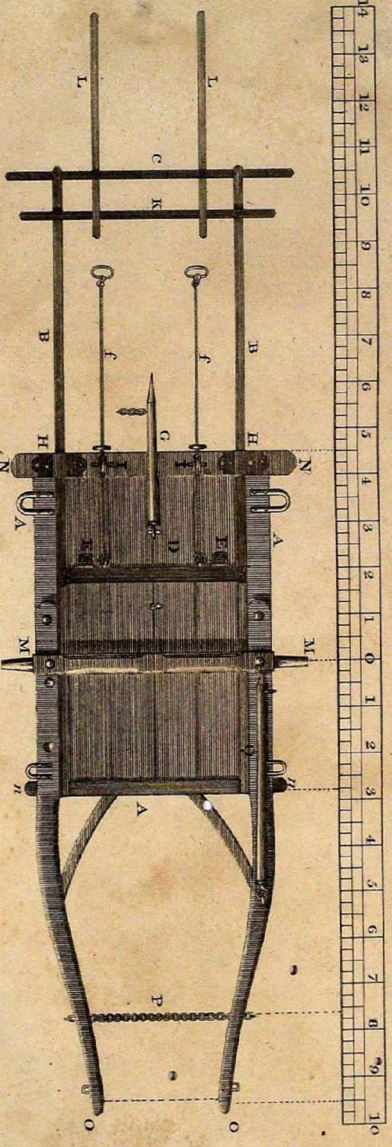


Fig 1.

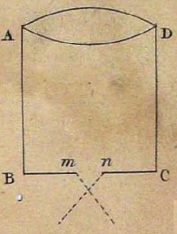


Fig 2.

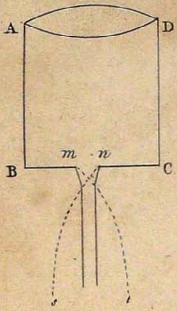
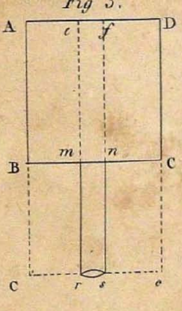


Fig 3.



XVI. *Specification of the Patent granted to Messrs.* JOHN WHITE, *of the Parish of Saint Paul, Covent Garden, in the County of Middlesex, Tin-plate-worker, and* JAMES SMETHURST, *of Saint Margaret's-hill, Southwark, in the County of Surrey, Tin-plate-worker; for their Invention of an improved Lamp-burner.*

Dated November 15, 1800.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, we the said John White and James Smethurst do hereby describe and ascertain the nature of our said invention, and in what manner the same is to be performed, as follows; that is to say: Our said invention consists in an improvement of the burner of a lamp, commonly called Argand's patent lamp; for which lamp his present Majesty granted his royal letters patent, bearing date on or about the fifteenth day of March, in the twenty-fourth year of his reign, to Ami Argand, of Great Marlborough-street, Soho, gentleman, as described in his specification, inrolled in the petty-bag-office, in his said Majesty's High Court of Chancery, on or about the third day of July 1784. Our said improvement, consisting in giving, or causing, a more free and plentiful supply of oil to the ignited part of the wick, by which contrivance it burns better, requires snuffing less frequently, and burns well with oil of an inferior quality; and has this farther advantage, that the burner can be more easily cleaned than burners of the common contrivance. These advantages are obtained by leaving

more

more room or ſpace between the two tubes where the cotton or wick is uſually placed than hitherto: it will be neceſſary, in this caſe, to reduce this ſpace at the top by putting on a ring or piece, conically or otherwiſe formed, that the cruſt or cinder may be conveniently bruſhed, or otherwiſe taken off; or the ſame effects may be produced by a creaſe or enlargement of the ſpace near the top, beginning at, or below, the place to which the oil flows, and ſo formed as to reduce the ſpace at the upper extremity to the uſual dimenſions. Nearly the ſame effects may be produced by ſupporting a ring or rings upon pillars or bars, or by making ſlits or openings in the ſides of the tubes, or by cauſing flues or creaſes to be made in the ſurface of the tubes, or otherwiſe, ſurrounding the ſurface, irregular or diſcontinuous, ſo as, by any means, to leſſen the points of contact between the cotton and the ſurface of the tubes, and thus aſſiſt the aſcent of the oil by capillary attraction. In witneſs whereof, &c.

Observations by the Patentees.

The Patentees deſire to ſtate, that there are other advantages in their improvement on Argand's lamps, than thoſe pointed out in the above ſpecification, *viz.*

Firſt. Argand's lamps have hitherto conſumed ſpermaceti oil only; whereas, by this improvement, either whale, elephant, ſeal, or ſeed oils, may be uſed, and will produce as much light as the former, and generally may be purchaſed at about half the price.

Secondly.

Secondly. The quantity consumed by these improved lamps is less, in the proportion of at least four to five.

Thirdly. The inconvenience hitherto complained of in the means of keeping them clean, is by this improvement removed, and the capillary tubes of the cotton wick are prevented from ever being obstructed by the glutinous principle of the oil; as the space between the tubes, which enclose the wick, are wider, and thereby admits a much larger body of oil between them than in the usual construction. A conical cap confines the cotton in the line of contact with the flame, which, being made to remove at pleasure, permits the introduction of a brush or other instrument between the tubes.

XVII. *Remarks on the Velocity with which Fluids issue from Apertures in the Vessels which contain them. By the Rev.* MATTHEW YOUNG, *D. D. S. F. T. C. D. and M. R. I. A.*

WITH A PLATE.

From the TRANSACTIONS of the ROYAL IRISH ACADEMY.

WHEN water issues from a small aperture in the bottom or side of a vessel, which is kept constantly full, it has been supposed, that the force accelerating the lowest plate of water, of indefinitely little altitude, immediately over the orifice,

fice, is the weight of the incumbent water only; and therefore, that after the motion of the plate has once commenced, the preſſure of the incumbent column will be diminiſhed, and of conſequence the force accelerating the plate, during its deſcent through its own altitude, will not be conſtant.

But, in fact, it is not the preſſure of the incumbent water, which accelerates the loweſt plate; for every plate of water immediately incumbent over the hole, abſtracting from all lateral preſſure, begins to be accelerated equally at the ſame moment; and therefore the incumbent column, excluſive of any lateral preſſure, could produce no increaſe of velocity, in proportion to its increaſed height. The force which really accelerates the iſſuing plate, is the preſſure of the ambient water, which ſurrounds the cylinder immediately over the aperture; and this lateral preſſure being communicated to the upper ſurface of the plate, muſt be as much encreaſed by the velocity of the ſuperior deſcending plate, as it is diminiſhed by that of the inferior iſſuing plate, ſo as to remain conſtantly of the ſame magnitude.

On this principle it can be eaſily demonſtrated, that the velocity with which water ſpouts from an aperture in the bottom or ſide of a veſſel, is equal to that which a heavy body would acquire in falling through the height of the fluid above the orifice.

This demonſtration, however, as Mr. Atwood obſerves, is true only on hypotheſis that the water ſuffers no reſiſtance, but iſſues in a cylindrical or priſmatic form correſponding to the hole. But, in fact, the velocity of the water according to theory will be diminiſhed by the friction of the

the particles against the edges of the orifice, from their mutual attraction, by which the issuing particles are retarded by those which are still in the vessel, and have not acquired the velocity of those which precede them, but principally from the obliquity of their motions.

For, as Chev. Du Buat observes, when water issues from an orifice, the particles will flow from all sides, towards the orifice, with an accelerated motion, and in all directions. If the orifice be horizontal, that filament of particles, which answers to the centre of the hole, will descend in a vertical line, and will suffer no other resistance than that of the friction caused by the excess of its velocity above that of the collateral filaments, or by the retardation which arises from the attraction subsisting between them. The other filaments, after they have descended vertically for some time, are compelled to turn from their vertical course, and to approach the orifice in different curves; and when they arrive at it, their directions become more or less horizontal, according as they pass nearer to or father from the edge of the orifice. The motion thereof is decomposed according to two directions, the one horizontal, which is destroyed by the equal and contrary resistance of the filaments which are diametrically opposite; the other vertical, in proportion to which the quantity of water discharged is to be estimated. Hence we see, that the vertical velocity of the filaments decreases from the centre of the orifice to its circumference; and that the total discharge is less than if all the filaments had issued vertically in the same manner with that which answers to the centre of the aperture. It also follows, that the filaments which are nearer

to the centre, moving faster than those which are nearer to the edges, the vein of the fluid, after it has issued from the orifice, will form a cone whose base is the orifice; that is to say, that its diameter will diminish, at least, to a certain distance, because the exterior filaments are gradually drawn on, in consequence of their mutual attraction, by the interior filaments whose velocity is greater; whence there follows a diminution in the diameter of the vein.

This manner of accounting for the contraction of the vein seems more reasonable than that which is given by Newton; as there appears to be no adequate cause for the acceleration of the water, after it has been discharged from the orifice.

The diminution of the mean velocity of the water, caused solely by the obliquity of the motions of the issuing particles, exclusive of any other impediment, may be thus determined:

Let *m n* (Fig. 1. Plate VII.) be the diameter of the aperture in the vessel ABDC filled with water: in whatever direction the water issues, its velocity in that direction will, in all cases, be the same, because the pressure of fluids is the same in all directions; thus, whether a fluid spouts perpendicularly upwards or downwards, horizontally or obliquely, the space through which it is projected, in a given time, is the same. Now to determine this direction, since the horizontal and vertical pressures are equal, the issuing particles will assume the intermediate direction, which will therefore form an angle of 45°. with the plane of the orifice: its vertical velocity therefore will be less than its direct or total velocity in the proportion of the diagonal of a square to its side, or as 7 to 5 nearly; but the particles of the

the central filament issue with the full velocity, due to the entire height of the water; therefore the velocity of the central particles will be to the mean velocity as 7 to the mean between 7 and 5, or as 7 to 6. This is the diminution, as has been said, which takes place in consequence solely of the obliquity of the motions with which the particles issue from the orifice: if the other causes of retardation be taken into the account, we may conclude, that the velocity should be diminished perhaps in the ratio of 8 or even 9 to 6; which accords very well with experiments. Thus Polenus makes the ratio of the diameters of the contracted vein and aperture, which is the same with that of the mean and greatest velocity, to be as $5\frac{1}{2}$ to $6\frac{1}{2}$; Bernouilli 5 to 7; Chev. Du Buat 6 to 9. When the orifice is infinitely little, the cylinder of issuing water becomes a single filament, which is therefore discharged without any obliquity, and there will be no diminution of velocity, except such as arises from friction and the tenacity of the particles. If the aperture be increased so as to become equal to the base of the vessel, the column of water will then descend like a falling body, and therefore the velocity will be the same as before; but it will not acquire this velocity until the uppermost plate of water has been discharged. At the beginning of the motion, the first or lowest plate will flow out with a velocity indefinitely little; the next plate with a greater velocity; and so on, until the upper plate shall have descended to the orifice, which will then issue with the greatest velocity. But if the vessel be supposed to be kept constantly full, the velocity of the effluent water will increase so as at length to become equal to that which a heavy

body would acquire in falling from an infinite height.

Since the middle filament of particles is difcharged with the full velocity due to the entire altitude of the fluid above the orifice, experiments made on the diftance or height to which fluids fpout, will be found to agree very well with theory, but it by no means follows, that all the filaments fhould be difcharged with the fame velocity: the quantity of the fluid therefore difcharged in a given time, may be lefs than that which would be difcharged, if all the filaments were difcharged with the velocity due to the entire altitude; becaufe this quantity depends on the mean velocity of all the filaments. Hence therefore it cannot be inferred from thefe experiments, compared with thofe which relate to the height or diftance to which the fluid fpouts, that the velocity of the water in the orifice is lefs than that which is due to the entire altitude; and that it is accelerated immediately after it gets out of it; becaufe the diftance to which the fluid fpouts depends on the central filament only, but the quantity difcharged on the mean velocity of the whole.

To bring this queftion to the teft of experiment, if all the particles were equally accelerated at their difcharge from the orifice, and immediately after they leave it, they ought all to be projected horizontally to the very fame diftance upon an horizontal plane; but on experiment I found, that when the fluid fpouted through an orifice of ,08 of an inch diameter, and was kept conftantly at the fame height, the greateft and leaft diftances at which it ftruck the horizontal plane were nearly 15 and 12 inches; but thefe diftances are proportional to the velocities with which they are dif-

charged.

charged. It follows therefore, that all the particles are not projected with the same velocity. It is to be observed, that the particles which are discharged with the greatest and least velocities are few in comparison of those which are discharged with intermediate velocities, for while the entire shower extended from 15 to 12 inches on the horizontal plane, the denser part was found to occupy only the space between $14\frac{1}{4}$ and $12\frac{3}{4}$ inches; so that the limits of the velocities of the parts of the denser shower were as 7 and 6,26; but the limits of the whole were 15 and 12, or as 7 and 5,6; and the limits by theory are as 7 and 5. But we may perceive, that when the fluid spouts horizontally, the particles which issue from the upper part of the aperture, and which therefore ought to move with the least velocity, must encounter those below them moving with a greater velocity, which will increase the distance to which they are projected on an horizontal plane. Likewise, the particles which issue from the lowest part of the orifice, and which ought to move with a less velocity, than that with which those in the axis move, in the ratio of 5 to 7, will have their velocity increased by their being at a greater depth. The limit therefore of the ratio of the distances to which the particles are projected on an horizontal plane, must be less than that which results from the theory of water issuing through an horizontal aperture. But it is obvious that the greater depth of the lower particles, when the orifice is vertical, cannot account for the entire difference of distance to which the particles are projected; for the depth of the orifice being 8,55 inches, and the diameter of the orifice ,08 of an inch, the velocities on account of the difference of

depth

depth would be only as $\sqrt{8,55}$ to $\sqrt{8,63}$, or as 14,6 to 15 nearly. Perhaps it might be ſaid, that this difference of diſtance was cauſed, not by the different velocities, but by the different directions in which the particles are diſcharged; ſo that thoſe which are projected in the axis of the vein, will ſtrike the horizontal plane at a greater diſtance than thoſe which are projected from the edges of the orifice with the ſame velocity, but in a different direction. But this cannot be the cauſe; for when the aperture is horizontal, the particles which iſſue from the oppoſite ſides *m*, *n* of the orifice (fig. 2.) meeting each other, deſtroy their convergence, and afterwards proceed in the direction of the axis of the vein, and therefore the vein will continue nearly of the ſame diameter: whereas, if the particles croſſed each other, with the ſame velocity, in different directions, they would deſcribe interſecting parabolas *n s*, *m t*, and the diameter of the vein would continually increaſe. In order to determine whether this were the caſe, I cauſed the fluid to iſſue through an aperture in the bottom of the veſſel, and at the diſtance of 12 inches I found the diameter of the vein a little increaſed, when the velocity of the efflux was conſiderable; but not ſenſibly augmented, when the velocity was much diminiſhed. Since the dilatation of the vein in this caſe depends on the velocity with which the water iſſues from the aperture, it is to be inferred, that it is cauſed by the reſiſtance of the air, which producing a retardation of the preceding particles, thoſe which follow impinge againſt them, and the thickneſs of the vein is increaſed; for the ſame reaſon as when the jette is made perpendicularly upwards, a broad head is formed in conſequence of

of the retardation of the uppermost particles. Now since it appears, that the dilatation of the vein which arises either from the different directions of the particles, or the resistance which they undergo from the air, or both together, cannot account for the difference of distance to which the particles are projected on an horizontal plane, we must conclude that this difference is caused by the different velocities with which they escape from the orifice.

When a tube *mnrs* (Fig. 3.) is inserted into the vessel ABCD, it is found, that the velocity is increased nearly in the sub-duplicate ratio of the length of the pipe, when the tubes are short; and that it approaches nearer to that sub-duplicate ratio, according as the length of the pipe is increased. To account for this increase of velocity has appeared a matter of some difficulty, since the water cannot issue at *rs* with a greater velocity than it enters at *mn*; and it does not appear how the velocity at *mn* can be increased by inserting a tube beneath it. In order to explain the cause of this effect, we are to consider, that the whole force with which the plate *mn* is pressed down is the weight of a column of water equal to *emnf*, together with the weight of a column of air of the same base, reaching to the top of the atmosphere; and the whole force with which it is pressed up is the weight of an equal column of air, diminished by the weight of a column of water equal to *mnrs*; therefore the actual force with which the plate *mn* is pressed down is the weight of a column of water equal to *efrs*; the velocity therefore with which the plate *mn* will issue through the orifice *mn* will be the same as through the orifice *rs* in the vessel A*bc*D; that is, equal to the

the velocity which a heavy body would acquire in falling through the altitude *er*; and all the plates of water in the tube *mnrs* will defcend with the fame velocity; for they cannot defcend fafter, becaufe otherwife there would be a vacuum left in the tube, which is prevented by the upward preffure of the atmofphere. And the velocity of the effluent water will be the fame, whatever be the preffure of the atmofphere, provided the weight of a column of air of the fame bafe with *rs*, and whofe height is equal to that of the atmofphere, be either greater than or equal to the weight of the pillar of water *mnrs*. This might be proved experimentally by a veffel of water with a pipe inferted in the bottom, placed under an exhaufted receiver. But as the operation of exhauftion is obftructed more by the evaporation of water than of mercury, it will be better to ufe mercury in thefe experiments. Now if D be the defect of the gage from the ftandard altitude, it will meafure the preffure of the air on the furface of the mercury in the veffel; let A be the altitude of the mercury in the veffel above the upper orifice of the pipe, and P the length of the pipe; then the whole force preffing downwards the plate of mercury which is immediately in the upper orifice of the pipe, will be $= D + A$; and the whole force preffing the fame plate upwards will be $D - P$; and the difference between thefe forces will be the abfolute force preffing the fame plate of mercury downwards; while D is greater than P, this abfolute force will confequently be equal to $A + P$; when $D = P$, $D - P$ vanifhes, and the force preffing the plate downwards is $= D + A = P + A$; hence therefore no variation in the time of the efflux will be perceived, while the altitude

of the mercury in the gage is equal to or lefs than the difference between the length of the pipe and the ftandard altitude. When D is lefs than P, the force upwards is alfo nothing; and therefore, as before, the whole force preffing the plate downwards is $=D+A$; and A being given, it decreafes according as D decreafes; and when D vanifhes, that is, when the receiver is abfolutely exhaufted, the force becomes equal to A, and the time of the efflux will be the fame, as if the pipe had not been inferted in the bottom of the veffel. To try the truth of thefe things by experiment, I inferted a tube 7,8 inches long in a cylindrical veffel, and clofing the orifice of the pipe, I filled the veffel with mercury to the height of 6 inches; then placing the apparatus under the receiver of an air-pump, when the barometer was at 30 inches, and the gage at 28,5, the time of the efflux was 26 feconds: when the experiment was repeated precifely in the fame manner, but in the open air, the time of the efflux was only 19 feconds. Now as the gage ftood at 28,5 the defect D was $30-28,5=1,5$, and the preffure on the plate of mercury was $=6+1\frac{1}{2}=7\frac{1}{2}$; in the open air the preffure was $=6+7,8=13,8$; therefore the ratio of the velocity of the efflux in both cafes, which is the fame with the reciprocal ratio of the times, was $\sqrt{7\frac{1}{2}}$ to $\sqrt{13,8}$, or as 2,73 to 3,7; but 2,73 is to 3,7 as 19 to 26 very nearly. No difference was obferved in the times of the efflux, when in the open air and exhaufted receiver, unlefs the gage ftood higher than $22\frac{1}{2}$ inches; that is, unlefs the height of the mercury in the gage was greater than the difference between the length of the pipe and the ftandard altitude. In another

 experi-

experiment, when the gage ſtood at 27,9, the height of the barometer was 29,9; the defect therefore was = 2, and the preſſure = 8. But $\sqrt{8}$ = 2,828, and $\sqrt{13,8}$ = 3,7 but 2,828 : 3,7 :: 19 : 24, and by experiment the time of the efflux appeared to be 23 ſeconds. When the efflux is made in vacuo, it is obvious to obſerve, that the pipe is not filled during the efflux, as it is while the diſcharge is made in the open air.

Since the column of water in the pipe *m n r s* adds to the preſſure which the plate *m n* ſuſtains, by diminiſhing the upward preſſure of the air through the pipe, it appears that it produces this increaſe of preſſure in the plate *mn* alone, without producing any lateral preſſure in the water which is on a level with *mn*; for it is manifeſt, that if an aperture were made in *m* B or *n* C, the velocity of the water iſſuing through it would not be affected by the inſertion of the pipe; and conſequently that the plate *mn*, which is immediately in the orifice of the pipe, is the only one, on the ſame level, whoſe tendency downwards is increaſed by the inſertion of the pipe. Hence, the particles of water at the edge of the aperture, having their perpendicular preſſure increaſed by the weight of the column *m n r s*, without any increaſe of their lateral preſſure, they will iſſue through the orifice *m n* more perpendicularly; the ſides alſo of the tube will obſtruct the converging motion of the particles, and conſequently, on both theſe accounts, the quantity of water diſcharged through a pipe thus inſerted will exceed that diſcharged through a ſimple orifice, in a greater ratio than the ſub-duplicate of the height of the water.

water. And according as the length of the pipe increases, the ratio of the quantity of water actually discharged by experiment, to that which should be discharged according to theory, will increase; because the ratio of the perpendicular to the horizontal pressure increases, in the ratio of the sum of the depth of the vessel and length of the pipe, to the depth of the vessel. It follows therefore, that experiments made in this manner, will approach nearer to coincidence with theory, than when made with a simple orifice; except either when the tube is so long as that the friction of the fluid against the sides of the tube shall produce a sensible effect, or when it is so short, as not to be sufficient to give the particles a vertical direction. All which agrees very well with the experiments made by the ingenious Mr. Vince, of which he has given us an account in the Phil. Trans. for the year 1795. Thus he tells us, that having inserted a tube, a quarter of an inch in length, into a cylindrical vessel 12 inches deep, he found that the velocity did not sensibly differ from that through the orifice; the cause of which he discovered to be this, that the stream did not fill the pipe, but that the fluid was contracted, as when it flowed through the simple orifice. When the pipe was half an inch long, inserted into a vessel of the same depth as before, the velocity of the water from the pipe and from the orifice, which ought by theory to have been as $\sqrt{12,5}$ to $\sqrt{12}$, or as 49 to 48, was by experiment found to be nearly in the proportion of 4 to 3. Now if the ratio of 49 to 48 be increased in the ratio of 7 to 6, (because this is the ratio of the diminution of the velocity on account of the contraction of

the vein, and this contraction either nearly or entirely vanishes in a pipe), we shall have the ratio of 3,57 to 3. When the pipe was an inch long, the velocity from the pipe and from the orifice, which, according to theory, ought to have been as $\sqrt{13}$ to $\sqrt{12}$, or as 26 to 25, appeared by experiment, very nearly in the ratio of 4 to 3; now if the ratio of 26 to 25 be increased in the ratio of 7 to 6, we shall have the ratio of 3,64 to 3. When he made use of longer pipes, the velocity of the effluent water by experiment approached nearer to that which ought to have been discharged according to theory; so that in long pipes, the difference between theory and experiment, he says, was not greater than what might be expected from the friction of pipes, and other causes which may be supposed to retard the velocity. When he inserted a pipe of the same diameter with the aperture, which terminated in a truncated cone fixed in the orifice, (Fig. 4. *) he expected, that the quantity of water discharged in a given time would have been diminished, because the water, issuing through the orifice *mn*, would have room to form the *vena contracta* in the enlarging cone; but he found, that the same quantity of water was discharged, as if the pipe had continued throughout of the same diameter with the orifice. The reason of this is manifest from what has been said, for the pressure of the air will not suffer the truncated cone to remain partly empty, as it would be if the *vena contracta* were formed; it will therefore continue full, and consequently the water will pass through it in the same manner as if the

* See the Philosophical Transactions for the year 1795.

water

water in the cone, surrounding the pipe *m a b n*, were congealed.

Mr. Vince likewise inserted into the bottom of the vessel a perpendicular pipe, in form of a truncated cone, the narrower part being fixed in the orifice; by which he found the efflux to be increased more than if he had inserted a cylindrical pipe of the same length, whose diameter was equal to that of the narrowest part of the conical pipe. This effect may be explained on the same principle by which we accounted for the augmentation of the diameter of a vertical vein of water, through a simple orifice, when the velocity of the efflux is considerable. For when a perpendicular pipe is inserted, the velocity of the discharge being considerably encreased, the resistance from the air will be so likewise; and thus the diameter of the vein has a tendency to enlarge itself; now in the widening cone, the pipe admits of this augmentation, at the same time that it increases the velocity; but the cylindrical pipe, though it equally increases the velocity, yet it does not permit the vein to enlarge itself, and by thus confining it, the efflux is obstructed, and the quantity discharged in a given time is diminished. Accordingly, under the receiver of an air-pump, even in a moderate degree of exhaustion, there is no difference perceived between the velocities with which a fluid is discharged through a conical or cylindrical pipe.

XVIII. *Description of a Sliding Lever, to be fixed to the under-side of a Cart, for the Relief of Horses when thrown down and entangled in the Thills, invented by Mr.* JOHN SNART, *Optician, Tooley-street, London.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

THE Society wish, for the sake of humanity, to alleviate the cruelties to which horses are subjected, and hope the plan here given will afford a useful hint for further improvements in this line. This machinery, which the inventor calls an Alexippos, will afford some advantages in loading carts, where the common length of the cart is too short for the articles intended to be carried.

AAA, plan of a common town cart inverted.

BB, sliding bars or levers, *i. e.* the Alexippos.

C, cross-bar, or handle of the Alexippos.

D, the connecting bar to project the Alexippos.

EE, stops, to prevent over-drawing ditto.

ff, ropes and hand-rings to project ditto, which may be put under the sliding bars BB.

G, prop to prevent hanging the horse.

HH, the bearing plates of the Alexippos.

II, the pulleys, or shivers.

K, the extra bar for country carts.

LL, the handspikes for ditto.

MM, the axle-tree, or fulcrum.

NN *n n*, hind and fore ear-breadths.

OO, the

OO, the extremities of the ſhafts.

P, the back chain.

Q, the prop.

As all librating bodies act in an exact and direct ratio to their elongations from the fulcra, conſidered in connexion with their proportion of weight, and *vice verſâ*, (the firſt reſiſtance by the inequality of their matter being excepted), it appears, that as is the ſolidity of the part reſting on the fulcrum, to the ſolidity of its extremities, ſo is its reſiſtance to be acted upon by a weight which is leſs than its diſproportion: which inequality of power is to the weight added in an inverſe ratio, but directly as the diminution.

It is evident that the conſtruction of carts at preſent is very unfavourable to the relief of the fallen horſe, who is intentionally placed at the longeſt arm of the lever (for the ſhafts act as a lever by ſuppoſing the axle-tree to be the quieſcent fulcrum), that he may the better reſiſt the weight of the load, ſhould the equilibrium be by any means deſtroyed; for any given weight upon the hind part of the cart has leſs than half the power of reſiſtance of the horſe; ſo that, if ſuch horſe falls, this advantage is prejudicial to his being raiſed. The inventor, therefore, of the Alexippos, preſumes that a plan, the baſis of which is humanity, will ſufficiently apologize for his offering to the public an invention which ſo obviouſly more than counteracts the before-mentioned diſadvantages, as may be ſeen by inſpecting the plan in connexion with its ſcale.

Let A A A (Fig. 4. Plate VII.) be a plan of the common town cart, whoſe hind ear-bred, or ear-breadth, N N, projects from its fulcrum, or axle-tree, MM, 4 feet 7 inches, while the back chain P is

is 7 feet 6 inches; and the extremes of the shafts, O O, which press upon the tuggs in the horses collar, are 9 feet 6 inches. Now, admitting that the horse who falls weighs 15 cwt. and that his bearing is 1 cwt. which is 16 cwt. it is very evident that it will require 3316 lb. weight gross at the ear-breadth N N, (which is but 4 feet 7 inches from the fulcrum M M), to counteract such a weight; even admitting that the load had not slipped forward at all by the concussion and depression of the fore parts of the cart. The estimate, therefore, now will be nearly as follows: 4 feet 7 inches, or 55 inches, to 9 feet 6 inches, or 114 inches, will give for the weight 3316 lb. which is more than that of twenty-two men, at 150 lb. weight each, before a disabled horse can be raised from the ground: but we know that six men cannot bear their weight with advantage on one of our present made carts, without endangering their persons or clothes, or both; so that the horse is left to struggle with three-fourths of the weight himself, and this in a very bad posture, as he is embarrassed by the shafts, &c. Hence, many horses, if not immediately killed, are at least ruined for ever.

The advantage of the Alexippos is in the proportion of 126 inches, the length of the levers at C, to 114 inches, the length of the shaft, viz. O O; and this without the addition of the handspikes L L, which gives a further advantage of one-fourth. Again, if 55 inches, the length of the lever, at N N, require $3316\frac{20}{35}$ lb. weight, what will 126 inches require? Answer, $1447\frac{58}{126}$ lb. which is less than the weight of ten men, at 150 lb. weight each. This, however, is not half the advantage of the Alexippos, as it affords convenient

accom-

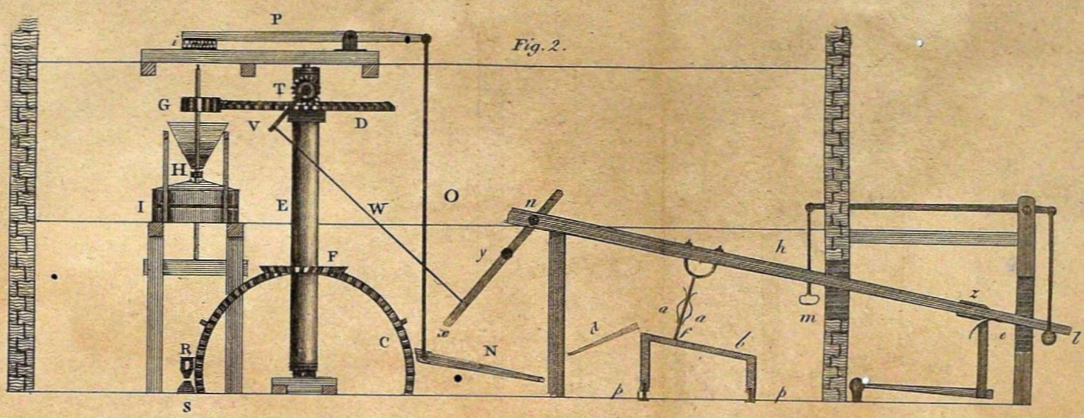


Fig. 2.

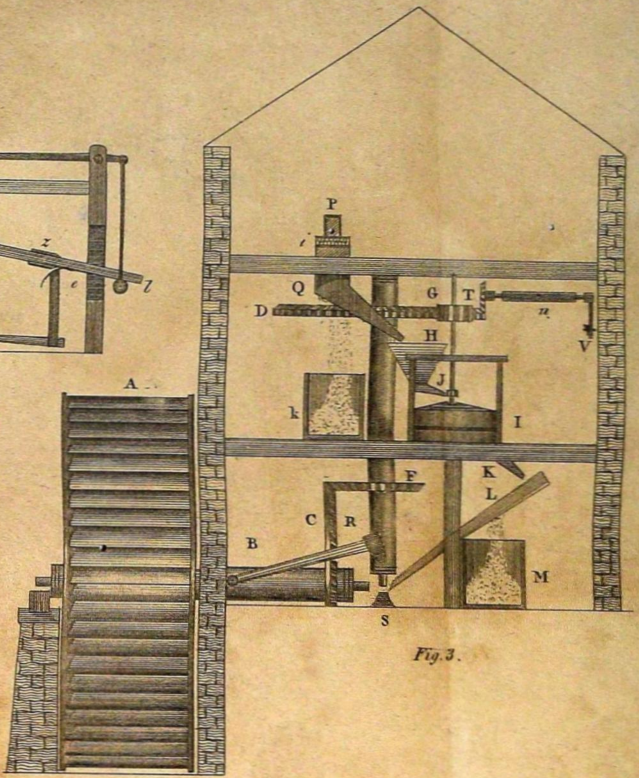
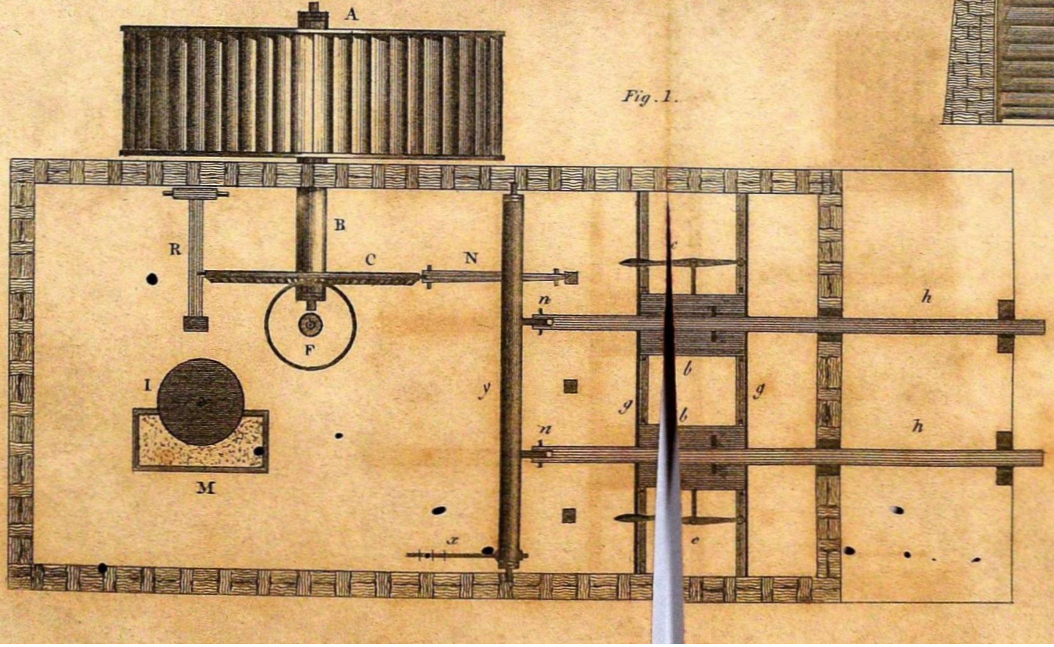


Fig. 3.

Fig. 1.



accommodation for more than twenty men, without hazard to clothes or persons. And, if we suppose a sliding bar at K, one man, (if men are scarce, as in the country) by applying the two handspikes L L, may gain power sufficient to raise his horse himself, especially as it fortunately happens that country luggage very frequently consists of such articles as might be removed from the front of the cart, and placed on the bars C and K; such, for instance, as sacks of corn, seed, potatoes, bran, flour, peas, beans, &c. &c. which, by being taken from the front, and placed behind, would have more than double the advantage of its real weight; and, in town, where the luggage is different, assistance is always to be obtained from humanity.

Notwithstanding the statement of powers for relief which I have here given, it is plain, from daily observation, that less than half the power here stated is only used in general, as eight or nine men can often (though with much danger and trouble) raise the fallen horse. Hence, by using the Alexippos, three or four men, without danger, delay, or trouble, will be sufficient.

XIX. *On the Cause and Cure of the Disease called the Curl in Potatoes.*

(Concluded from Page 51.)

ONE method of preventing the disease, namely, by changing the seed, has been already mentioned: another source of prevention offers, from

raiſing new kinds from the ſeed or apple of the plant, or the ſame kinds renewed again from the ſeed. Raiſing new kinds from ſeed, however, requires no ſmall portion of diſcernment; for the ſeed from the ſame plant will produce ſo many varieties, that it requires nice judgement of the cultivator properly to ſelect. Great numbers, from inſpection only, will be weeded out and rejected; and of thoſe retained, more will be again rejected, the ſucceeding and following years: of the remaining few, there may different characters ſtill exiſt; ſuch as ill or well flavoured, cloſe or coarſe grained, productive, non-productive, &c. &c. Each may have their reſpective value: but I think it may be generally aſſerted, that the finer kinds ſooner degenerate; the coarſe kinds, which are almoſt, if not always, more productive, retain their vigour the longeſt *. The following example confirms this opinion.

Spring, 1785.—I procured a new kind of potatoe, called a Dabb, lately raiſed from ſeed; where, I know not: the character of which was large, coarſe-grained, ſtrong-flavoured, and of

* This may have been the reaſon the diſorder did not appear before the introduction of new kinds; for it has been obſerved, that the old winter red never curled. Refinements of every ſort have their advantages and diſadvantages. By the introduction of new kinds, we obtained ſuperior potatoes, but more liable to decay: and yet the ſuperior qualities of the new, it is likely, would ſuperſede the cultivation of the old winter red; probably a coarſe ſpecies, but well thought of, when there were no better ſorts.

I have been told that a valuable apple for cyder is worn out; nor can all the efforts of the cultivator renew it from grafting. If this be a fact, there ſeems a ſtriking analogy in the decay of each, from too long planting on the ſame ſoil, and it requires the induſtry and ingenuity of man to ſeek out freſh ſtocks from the firſt ſource, ſeed.

courſe

course rejected from the table; but being very productive, was useful for cattle. The last year it was so much improved, as to be no longer rejected: it still retains the quality of being productive, even so much as yielding, this present year, six bushels from every statute perch. It should be observed, that the present very luxuriant crop may be in great measure owing to having been planted on a virgin soil, which was never before improved, or broken up; very little dung was used. Here is an evident change for the better; the plants are vigorous, and there is at present no appearance of decay: this new soil may be a means of preserving the plant a few years longer; but a total change of seed will, in time, become absolutely necessary.

Hence it should appear, that although the disease, after the present stock has been, to a certain degree, infected, can never be cured, yet means may be taken for prevention: and that this is the case in this district is evident; few crops, of late years, having failed, by being much infected with this disorder; for, wherever the curl has appeared, in ever so small a degree, that stock has been rejected by the attentive cultivator, and new seed obtained.

It was so late as the year 1565, when the potatoe was first imported from its native soil, America, into Ireland; and afterwards (owing, as is reported, to a shipwreck) they were planted upon the sea-coast, in Lancashire, from whence their cultivation has been progressive, from the west, through every part of the kingdom; in some of which but very lately. It is also imagined, that this disease first appeared in this very district of the kingdom wherein they were first cultivated;

and this happened about the year 1764: a remarkable circumstance at which time I yet well remember; a person, full of enterprise, observing the curl in a few stems of a certain crop, and that they at the same time decayed, or arrived at maturity sooner than the rest, had them carefully selected out, imagining he had luckily obtained, somehow, a new and early kind; and had all of them planted the next season: that he was disappointed of his succeeding crop, was evident; but from what cause he was puzzled.

I am the more encouraged to offer these hints, for that, after having drawn them up, in the manner here sent, I read them over to a very intelligent farmer in this neighbourhood, who said that these thoughts totally corresponded with his own. I have shown them also to a respectable clergyman, who, to his other many excellent qualities, is always ready to communicate information, and has favoured me with the following extract from a private letter.

"A labouring man in my neighbourhood has "got a very good potatoe: the only fault is, that "out of four plants, three of them are abominably curled; on which account, I desired he "would give me four potatoes. From each potatoe I took a *shoot*, not a *set*, in order to see if "the shoots would be curled; they were not: so, "possibly their not being curled may be accidental, or possibly the curl may arise from the "*set* planted. Another year, I will plant a dozen, or more, of these potatoe-shoots: then, "if there should be no curl, I shall be clearly of "opinion, that the curl arises from some disease "in the *set*. What I mean by a shoot, is—I "put three or four sets into a flower-pot; when "they

" they have ſhot to be about two inches high,
" and have fibres, I take the ſets up, and with a
" knife cut the ſhoots off, leaving not the leaſt
" piece of a ſet on the ſhoot. I then plant the
" ſhoots.

" S. H."

Hurſely.

It ſhould appear, from the above ingenious experiment, of which future trials will confute or confirm the fact, that it corroborates the above theory, by proving the diſeaſe in the ſet; and which, when the cauſe or ſeat of the diſorder is lopped away, the cure is effected by the force of nature to heal itſelf, and the power of vegetation on the ſmall fibres, which retain newly-acquired life, though from an infected parent ſtock.

The nature of vegetation is ſo myſterious, that we muſt acknowledge our ignorance in her wonderful proceſs. We know that many varieties of fruits may, by a ſingle bud of each, be inoculated upon one and the ſame ſingle ſtock; and that, from this one root or fountain-head, may be obtained the different fruits therein depoſited: but by what law of attraction or repulſion this common ſtock or parent can divide, aſſimilate, correct and adjuſt, the different particles of matter of which each fruit is diſtinguiſhed, by ſhape and flavour, is beyond our reach to know. It is true, that but a very ſmall part of the food of plants or fruits is filtered through the roots of the plants: the leaves, the bark, the wood, imbibe from the atmoſphere, and perform their taſk; but being of different ſhape, texture, and grain, each has its ſeparate and particular mode of operation, and thereby cauſes different effects. Nor yet are we able to ſay, what it may be that gives the different

ferent flavours to fruit; whether from the component particles of matter differently arranged, or whether from the separate and component parts being of different shapes, &c. &c. These are secrets hitherto withheld, and probably ever will be hid from the search of man.

XX. *An Enquiry into the Causes of the Insalubrity of flat and marshy Situations; and Directions for preventing or correcting the Effects thereof.*

By Mr. WILLIAM CURRIE.

From the TRANSACTIONS of the AMERICAN PHILOSOPHICAL SOCIETY.

THAT flat and marshy situations are unfavourable to health, and that intermittent and remittent fevers, with bilious evacuations, are particularly prevalent in such situations during the season of autumn, in temperate climates as well as within the tropics, has been remarked by physicians and historians in every age.

But although they have agreed with respect to the fact, they have differed materially with respect to the cause of this circumstance.

A desire of ascertaining the true cause of this insalubrity induced me to engage in the enquiry which I am now about to submit to this respectable Society; and I hope the time and attention which I have bestowed, upon a subject so interesting to mankind, will not be deemed labour misemployed.

The

The atmosphere in salutary situations has been demonstrated, by M. Lavoisier and his colleagues, to be a compound body, consisting of two distinct gases or aëriform fluids, the one called azote or nitrogen gas, and the other oxygen gas or pure respirable air; and that in one hundred parts of the atmosphere, the proportions of these gases are 72 of the azote and 28 of oxygen, or as three to one.

From Mr. Vanbreda's experiments, on the atmosphere of marshes in the autumnal season, which he subjected to the common test of nitrous air in the eudiometer, it appears that these proportions were very different; there being but 14 or 15 parts of oxygen to 84 or 85 of azote, but that the bulk was supplied, and the same weight preserved, by a certain quantity of carbonic gas or fixed air, and a small portion of hydrogen and ammoniacal gases or aëriform fluids.

All these gases are the effects of vegetable and animal putrefaction, and must be derived from the soil, or the vegetable and animal substances connected with the soil.

The soil of marshes is composed entirely of vegetable and animal substances, which have undergone the process of putrefaction, and consists principally of vegetable earth, carbon or charcoal and nitre, mixed with more or less calcareous and argillaceous earth, and by distillation affords oil, hydrogen, and azote.

From this soil, and from the various vegetable and animal substances mixed with it, and constantly putrefying in hot weather, it has been supposed miasmata issue, which give origin to the diseases peculiar to marshy situations; and as there are no substances but those gases, already enumerated,

merated, which can be discovered to issue from a marshy soil, or from putrefying vegetable or animal substances, if those diseases depend upon miasmata or effluvia, these miasmata must consist of one or more of the gases enumerated *.

In order to determine this matter, it will be necessary to enquire into the effects which these substances, singly, or combined, usually produce on the living human body.

If the carbonic gas or fixed air, when applied in a certain quantity, or in a concentrated state, destroys life instantly by its action on the irritability of the muscular fibres of the heart, as from the observations of Messrs. Priestley, Bergman, Fontana, Cavallo, and other philosophers of credit, appears to be the case, nothing is more pro-

* "In the vinous fermentation, part of the principles of the vegetable substance, viz. the hydrogen, remains united with a portion of water and of carbon to form the alkohol.

"In the acetous fermentation, a union takes place between the oxygen and the alkohol, and earthy matter is deposited. In other words the base of the pure air absorbed, uniting with the alkohol of the liquor, and the essential salts dissolved in it, forms vinegar, while a deposition takes place of earthy or oily matters no longer soluble in the liquor. Hence vinegar is in an intermediate state between wine and fixed air, accordingly vinegar may be made by impregnating alkohol and water with fixed air.

"The gas of fermenting liquors which is fixed air, holding some spirit of wine in solution received into water, has the same effect.

"In the putrid fermentation (which is the only species that takes place in marshes) the whole of the hydrogen is dissipated, under the form of inflammable gas, while the oxygen and the carbon uniting, with the caloric or principle of heat, escapes under the form of fixed air;" after this process, if there has been sufficient water and heat to complete the putrefactive process, nothing remains but the earth of the vegetable, mixed with a little carbon and iron. CHAPTAL.

bable

bable than that a less quantity, though much weakened by diffusion in, and mixture with, the atmospheric air, would operate in a similar manner, though in a less degree, and occasion a disease of a paralytic or insensible kind, and not an intermittent or remittent, since in these last the sensibility and irritability are manifestly increased.

* That the hydrogen gas or inflammable air has little or no share in the generation of the diseases under consideration, is rendered evident by the experiments of Chaptal, De Rosier, and Beddoes.

The former assures us, that he inspired it several times, without perceiving any effect from it, and that it returned from his lungs without any alteration either in weight, bulk, or quality, whereas common atmospheric air suffers a very material change by respiration, its pure or oxygenous portion being abstracted, and the remainder rendered incapable of supporting flame, and unfit for respiration.

De Rosier not only inspired inflammable air, but applied flame to it as he discharged it through his nostrils, without receiving any injury from it. He also discharged the burning gas from his mouth through a tube, so that he appeared to breath flame.—No detonation took place in his mouth, because he had discharged all the atmospheric air from his lungs, before he inspired the inflammable air.

* It appears from the experiments of M. Lavoisier, that hydrogen is also the result of decomposed water; and that water is a composition of hydrogen, and oxygen kept in a fluid state by its union with caloric, and consists of 85 parts in 100 of oxygen and 15 of hydrogen.

Dr. Beddoes prevailed on a ftout florid young woman, to infpire hydrogen for two minutes, without any perceptible effect, except a flight giddinefs after fhe had defcended a flight of ftairs.

No alteration is made in their properties by the mixture of carbonic with hydrogenous gas. No decompofitions takes place, no caloric is fet at liberty, or heat rendered fenfible of fuch union. We may, therefore, from what has now been ftated, conclude that neither carbonic nor hydrogen gas, fingly or combined, is the miafma or effluvium by which the difeafes in queftion are produced.

In confequence of the putrefaction of farinaceous plants, and all fuch as abound more in gluten than in the faccharine, or mucilaginous principles, as well as from the putrefaction of animal fubftances, an ammoniacal gas is produced, owing to the union of the hydrogen, evolved in the putrefactive fermentation, with the fuperabundant azote of the atmofphere *. But this gas, inftead of diminifhing the powers of the human body, is well known to have a contrary effect, except when received into the lungs in a large quantity, and then it proves deftructive from its ftimulating quality, inducing a fpafm on the glottis or bronchiæ. That neither the water of marfhes, nor the exhalations which arife from thence, are feptic or promoters of putrefaction, has been fully demonftrated by the experiments of Dr. Alexander †.

But

* Does the union of dead animal and vegetable fubftances prevent the noxious effects of each other?

† Having filled a tea-cup with putrid water, taken from a ditch, in the meadows on the fouth fide of Edinburgh, (which

But that any exhalation, or other fubftance, fhould act on the moving powers or folids of the human body feveral days after it has been received into the body, without making fome material change in the condition or quality of the circulating fluids, is inadmiffible, becaufe it is fcarcely conceivable. That fuch alteration is made in the quality of fluids in putrid fevers is manifeft from the contagious effects of the feveral excretions. But in cafes of intermittents and remittents, which originate in marfhy fituations, no fuch evidence is afforded, for there is no authentic inftance of thefe being contagious or communicable from one to another.

As no other exhalations or noxious matters than thofe which have now been enumerated, can be difcovered in the moft unfalutary atmofphere of marfhes; as there is no fource from whence

(which in fummer contain a confiderable quantity of extremely putrid ftagnating water,) and another cup with pure water, "I put a bit of mutton into each cup, and fet them together in the open air. The mutton in the pure water began to putrefy in about 56 hours. At the end of three days, that in the marfh water was quite fweet. On the fifth day it was taken out, wafhed carefully with pure water, and found perfectly fweet. That in the pure water was now become intolerably fetid, and on that account was thrown away. The feventh day the mutton in the marfh water was wafhed again, and found as frefh as before. When it had lain in about fix weeks, it ftill continued perfectly fweet, and the liquor around it of the fame fmell and colour as at firft. After two months, things were exactly the fame. The mutton was then thrown out." Alexander's Experimental Enquiry, p. 71.

From the experiments of the fame gentleman it appears, that pieces of dead flefh, fufpended over the exhalations of the putrid water of marfhes, are five or fix days longer putrefying than thofe fufpended over the exhalations of pure water. (See his 15th and 17th experiments.)

any other noxious fubftance can be introduced into the atmofphere of fuch fituations; and as it is evident, from the known effects of the gafes which have been difcovered in it, that they cannot have the effect of producing the difeafes under confideration, either when applied fingly or united, we certainly ought to hefitate before we adopt the doctrine heretofore taught, refpecting marfh miafma.

But as it is well known that a very material alteration is made in the proportions, which one of the component parts of the atmofphere bears to the other, by certain proceffes of nature and art, let us enquire how far the alteration which is made in the atmofphere and marfhes, by the procefs of putrefaction may affect the prefent queftion.

Mr. Vanbreda's experiments prove, that there is lefs oxygen in the atmofphere of marfhes during autumn, when the weather is dry and hot, than in more falutary fituations, and it is well known, from innumerable experiments, made by different philofophers, that this can only be diminifhed by combuftion, fermentation, putrefaction, or refpiration, or a procefs of a fimilar kind.

It is alfo a fact, fully eftablifhed, that the functions of life, as well as the procefs of combuftion and fermentation, can only be continued by the application of oxygenous gas, and that thefe are affected in proportion to the quantity and purity of the gas applied.

TO BE CONCLUDED IN OUR NEXT.

XXI.

XXI. *Obſervations on the Nature of Steel, and particularly on that Species obtained directly from fuſed Iron, which is termed* NATURAL STEEL.

FROM THE *ANNALES DE CHIMIE.*

IT has juſtly been remarked, for ſeveral years paſt, that the ſteel of France, particularly that ſpecies which is termed *natural ſteel*, will not bear competition with that of other countries, and that the endeavours of our learned men have not ſucceeded in enabling us to produce *uniformly* ſteel equal in quality to that of Germany.

The imperfect ſtate, in which this branch of induſtry has hitherto remained, is proved by the judgment of the heads of manufactories, and of the artiſts who make much uſe of ſteel in their operations; as alſo by the very conſiderable quantities (amounting to about 1,800,000 livres *per ann.*), which are ſtill imported from abroad by the contractors for our large military and naval eſtabliſhments.

We ſhall content ourſelves with mentioning the celebrated manufactory of arms at *Klingenthal*, which ſupplies that at Verſailles with what are termed Damaſcus blades; for the contractors, being unable to find good natural ſteel in France, are obliged to procure theirs from the founderies of Styria and Naſſau Siegen*.

It will therefore be uſeful to inveſtigate the cauſes of the inferiority of the French ſteel, particularly that of the caſt ſpecies, of which we

* In theſe founderies, only the ſpathic ores are employed.

have

have no manufactory which can furnish any equal to that of Germany, and which contains the same principles.

The commissions with which I was entrusted by government, relative to the founderies, having enabled me to make comparative analyses of the greater part of the iron-ores of France, I found that the good quality, and the uniformity of the quality, of the natural steel depended (abstractedly of the carbon, and the known processes for rendering it more homogeneous) upon its possessing a certain quantity of manganese, which in conjunction with the carbon constituted the best foreign steel; whilst in France they indiscriminately employ, in the manufacture of this steel, iron-ores, which either do not contain this substance, or do not contain it in the requisite proportions. Hence all that uncertainty in the judgements that have been passed upon the uses of our steel; hence the disappointments which manufacturers have met with, and the differences which are found in the properties of our steel compared with that of foreign countries.

Bergman had discovered that manganese was contained in the white, or spathic iron-ores.

Citizen Vauquelin has shewn, by his ingenious analysis of the steels of the *Dep. de la Moselle*, that they contained phosphorus; and he has pointed out various new processes for separating with greater precission the principles which might be found in cast iron and steel; processes which, together with that of the distilled acetous acid for separating the manganese, induced me to recommence all the experiments which I had before made according to the method of Bergman.

Citizen

Citizen Berthollet, in ſpeaking of the natural ſteel, ſays, "That the ſmall quantity of manganeſe that had been diſcovered in good German ſteel, is an intereſting circumſtance which requires more accurate examination than has heretofore been beſtowed upon the ſubject."

The new experiments which I have made upon ſteel, and which I wiſhed to repeat in founderies where carbonates of iron or ſpathic ores are uſed, are however ſo far advanced, as to perſuade me that the natural ſteel which is uniformly obtained of a good quality, is not only a combination of pure iron with carbon, but an alloy of pure iron with manganeſe, combined with carbon.

In order to aſcertain whether this opinion were well-founded, I inſtituted a ſeries of experiments, the object of which was not only to determine how much carbon and manganeſe was contained in the ſpathic ores, and the caſt iron and ſteel of the beſt founderies of Germany and France, but likewiſe to follow the paſſage of the manganeſe in the different ſtates of the iron obtained from theſe ores.

When we analyſe the ſpathic ores of iron cryſtallized in large laminæ and rhomboides, we generally obtain not more than 2 per cent. of carbonate of manganeſe; and the iron thus obtained is of the firſt quality.

But, in analyſing thoſe ſpathic iron-ores which are cryſtallized in ſmall cruciform laminæ and rhomboides, and thoſe which derive from this ſpecies, and which are more or leſs oxydated, and which yield the iron which is moſt in requeſt for manufacturing ſteel, I found that theſe ores contained 7, 8, 9, 11, and even 13 per cent. of carbonate of manganeſe; ſo that theſe varieties of

ſpathic

ſpathic ores, which exiſt as well in France as in Germany, contain from 4 to 6¾ per cent. of metallic mangaueſe.

In analyſing afterwards the caſt iron and ſteel produced from theſe ores, in order to diſcover what takes place in the metallurgical operations, I obſerved that the fuſed metal which was deſtined and employed for the fabrication of the beſt ſteel, contained only from 3 to 4⅓ per cent. of mangaueſe, and that the ſteel manufactured from this fuſed metal retained ſtill from 2 to 2½ of manganeſe, a quantity more than ſufficient to impart new properties to the iron, and which coincides with the proportion of 4 and even 4½ of manganeſe, which I found in the caſt-iron of thoſe founderies of Germany in which ſpathic ores are uſed, as alſo with the proportion of 2 per cent. of manganeſe, which I obtained from ſix ſpecies of German ſteel of good quality.

What we obſerve in making our analyſis before the employment of the carbonates of iron, and after their converſion into caſt metal and ſteel, explains what happens in the metallurgical operations; a portion of the manganeſe, whilſt it effects a more ſpeedy and complete reduction of the iron, is ſeparated and vitrified; whilſt another portion, being reduced together with the iron, unites with it as an alloy, and remains in ſuch an intimate combination with it, that the long and ſucceſſive operations of drawing and welding of the natural ſteel, cannot extract from it more than about one-half of the manganeſe contained in the fuſed metal which is employed. The iron therefore acquires new properties in conſequence of its combination with manganeſe, and it is this alloy, which,

which, with 1 per cent. of carbon, constitutes the beſt natural ſteel.

Upon the influence of the mangameſe in the fuſion of the metal, and the proportions in which it enters into combination with it, depend eſſentially the properties and quality of the natural ſteel, as that principle generally exiſts in it in a proportion twice as large as that of the carbon, and this ſteel differs from that obtained from ores which contain no manganeſe, by the ſuperiority and uniformity of its quality; conditions, without which it would be impoſſible for us to diſpenſe with the importation of ſteel from abroad, or eſtabliſh a manufactory of ſteel that could ſupport itſelf.

Though I am well perſuaded that the natural ſteel of Germany owes its ſuperior quality entirely to the ſpathic ores of iron which are uſed in preference for manufacturing it, and to the manganeſe which it contains in the requiſite proportion, I think it neceſſary to adduce, in ſupport of this opinion, a fact, which had not been obſerved, namely, that in the German founderies, and eſpecially in thoſe ſituated in the territory of Naſſau Siegen, where very good natural ſteel is manufactured without difficulty, and where they have in the neighbourhood mines of manganeſe, they ſubſtitute the black oxyd of manganeſe as a flux, when the ſpathic ores and the fuſed metal employed for manufacturing the ſteel do not contain a ſufficient quantity of this ſubſtance.

Thus the reſearches that have been made by others, and my own experience, perfectly coincide with the reſult of operations performed in the large way, the products which I have examined, and with facts.

From the experiments and inquiries, therefore, which have been mentioned in a very summary manner in the present memoir, there result several new and important facts.

1st. The fused native-iron, in order to produce *uniformly* natural steel equal in quality to that of Germany, ought to be obtained in preference from carbonates of iron, which contain the largest proportion of manganese, and this metal ought to be contained in the fused iron intended to be manufactured into steel, in the proportion of 4½ to 5 per cent.

2. In good natural steel, the manganese ought to exist in a proportion twice as large as that of the carbon.

3. Steel in general, and particularly natural steel, are essentially alloys of iron and manganese combined with carbon, and this alloy is, in the natural steel of Germany, most commonly in the following proportions, *viz.*

Iron —	96,84
Manganese	2,16
Carbon —	1,00
	100,00

4. Not all the ores of iron are equally adapted for uniformly producing natural steel, that possesses all the properties which it ought to have.

5. The carbonates of iron, or spathic ores, which yield, when analysed, from 2 to 13 per cent. of manganese, require also that a particular selection should be made amongst them, and a very careful roasting, on account of the sulphur which they contain; and they ought to be employed for wrought-iron when they contain

tain not more than 2 per cent. of carbonate of manganefe; thofe which contain more may be mixed with thefe, and thus become fit for being manufactured into fteel.

6. It becomes ftill more neceffary to claffify thefe ores in a proper manner, as it has been found by analyfis, that they contain manganefe in very different proportions, and as it has been proved that a part of this metal is deftroyed in the courfe of metallurgical operations.

7. The proprietors of founderies which have ores of manganefe in their vicinity, might try with advantage to combine thefe ores with thofe of iron, in order to produce an approximation between the fufed metal deftined for the fabrication of fteel, and that produced from the fpathic and oxydulated ores, and from fome of the hæmatites, in which the combination of the iron and manganefe is already formed by nature.

It will readily be conceived from what has been advanced in this memoir, what ufeful experiments may be made in founderies which are fupplied with fpathic ores.

Finally, to confider the matter in a national point of view, it is to be obferved, that the mines of pure fpathic iron-ore, which exift only in five departments of France, are equal, nay fuperior, in value to mines of gold; and every poffible meafure fhould be taken to induce the inhabitants of thefe departments to turn their attention towards the improvement of the manufacture of fteel, in order that the Republic may at length be emancipated from the tribute of four millions of livres, which fhe annually pays to her enemies in the purchafe of fteel of every fpecies.

XXII. *Memoir on Mortars, Lime, Beton, and Pozzolana. By Citizen* GUYTON.

FROM THE *ANNALES DE CHIMIE.*

WE meet, in various works, with descriptions of processes for preparing mortars and cements; enquiries concerning the composition of those used by the ancients, in the construction of such of their edifices as have escaped the ravages of time; tests for determining their degrees of solidity in different circumstances; observations on the nature of the substances adapted for each destination; and descriptions of the characters by which they may be recognised. It appeared to me, that by collecting the leading facts and opinions one might obtain within a small compass a number of truths, which admit no longer of controversy, and which cannot be rendered too generally known. This is the object of the present memoir, in which I shall communicate several facts that have not been hitherto published.

Mortar of Loriot.

In the year 1775, the late M. Loriot pointed out a mixture of one quarter of quick-lime pulverised, with good mortar, made in the ordinary manner with slaked lime and sand, as an essential condition for obtaining structures equally durable with those of the Romans. (See his memoir, in *The Journal de Physique*, tom. III, page 231.)

Having observed the pulverisation of the lime to be a troublesome operation, and even a dangerous

gerous one for the workmen, who, in ſpite of every precaution they can uſe, are ſubject to bleeding at the noſe; I propoſed to let the lime be covered, and when ſpontaneouſly reduced to powder to re-calcine it in a ſmall kiln, and to uſe it quite hot.

This proceſs is deſcribed in all its details, in a printed memoir (Journal de Phyſique, tom. IV, page 418). It has ſeveral times been practiſed on a large ſcale, and always with complete ſucceſs, which will be no matter of ſurpriſe, when it is conſidered that thereby the two principal objects are obtained; namely, a *very fine powder*, and *freſh lime*.

The deſcription of the kiln, with plans, ſections, and profiles, is to be found in an inſtruction, printed by order of the government in the year 1775, and in the Journal de Phyſique of the ſame year, (tom. IV, page 311). The dimenſions have been given, ſo as to enable ſeveral workmen to carry on their labours without interruption; as alſo the proportions that have been judged the beſt, for the compoſition of the mortar. Theſe are in ten parts:

Fine ſilicious ſand, — — —	3
Well-burnt bricks pounded, —	3
Slaked lime, — — — — —	2
Lime killed in the air and re-calcined,	2
	10

Mortar of Lafaye.

In the year 1777, Lafaye publiſhed an inquiry concerning the manner in which the Romans prepared their lime and compoſed their mortars; the practical

practical part of which has been extracted in a very detailed manner, in the Journal de Physique, for the month of June of that year, (tom. IX, part 1st. page 437).

The principal article is the manner of killing lime without liquefying it, so as to reduce it to powder, and still leave it sufficiently caustic to yield a very strong mortar, and one which will grow harder in proportion as it grows older.

For this purpose, we are to take good fresh lime made of hard lime-stone, which is to be broken in a mortar into pieces of about the size of an egg; these pieces are to be put into a shallow open basket, which is to be plunged into water, and kept there till the surface of the water begins to boil: the basket is then drawn out and suffered to drain for a moment; after which the lime is put into casks, where it soon becomes heated and crumbles into powder.

It is the lime prepared in this manner which is mixed with various compositions of mortar, according to the purposes for which they are intended to be employed. It will keep very well, if we cover the casks with straw.

I have employed this lime in the construction of a small aqueduct, upwards of fifty metres in length, which was intended to convey water to an artificial nitre-bed, near Dijon, about eighteen years ago. The mortar made of three parts of this lime, with three of sand, and three of fragments of hard calcareous stone, acquired in a short time a great degree of firmness and solidity, though situated under ground.

Of

Of poor Lime. (Chaux Maigre).

In ſome countries a ſpecies of lime is known, which is termed poor lime, becauſe, when employed in equal quantity, it does not afford ſo fat a mortar as the other kinds; but this poor lime has a property which renders it very valuable; namely, that of acquiring a ſolid conſiſtency, and of growing hard in water.

It was not known upon what this property depended, till Bergman ſhewed that it was owing to the oxyd of manganeſe, which the lime-ſtone of *Lena* contains in the proportion of about two to a hundred; as ſtones which form a mortar capable of hardening in water, do likewiſe. (Opuſc. tom. II, diſſert. xix, § 10, page 236, of the French edition).

In the year 1783, I publiſhed, in the ſecond ſemeſtre of the New Memoirs of the Academy of Dijon (page 90), a ſeries of experiments on ſix ſpecies of poor lime ſtones, amongſt which was the ſtone of *Lena*, which had been ſent me by Bergman: only two of them acquired by calcination that brown colour which is indicative of the preſence of manganeſe, or bore the compariſon with the ſtone of Lena, in the trials which I made with them.

Beſides the poor lime ſtones deſcribed in this memoir, which are thoſe of *Lena*, of *Brion*, in the department of Saône-et-Loire, and of *Morex*, near Geneva, I am at preſent acquainted with two others, *viz.*

1ſt, That employed at *Metz*, in works under water, the analyſis of which has been

given in the *Cours de l'Ecole polytechnique*, of the year 6 *.

2dly, That which Mr. Smeaton, the architect of the Edyſtone light-houſe, has deſcribed in his eſſays, and which is found at Aberſhaw, in Glamorganſhire. I have no doubt that there may be found in many other places, and in the territory of the Republic, ſtones of the ſame quality †, that is to ſay, which contain manganeſe, and are naturally mixed with a pretty conſiderable quantity of ſilex and alumine; for it is very evident that this laſt condition contributes much to produce a poor lime, or an almoſt native mortar, which admits only of a ſmall addition of ſand, pounded brick, or other dry ſubſtances.

Artificial Poor Lime.

In want of poor lime-ſtone, I have a long time ago propoſed to procure a ſubſtitute for it, by mixing four parts of grey argill, and ſix of the black oxyd of manganeſe, with ninety parts of good lime-ſtone reduced to powder.

* From this analyſis it appears, that the poor lime-ſtone of Metz contains in a hundred parts:

Carbonic acid —	39,00
Lime — —	44,5
Silex — —	5,25
Alumine — —	1,25
Manganeſe —	3,5
Oxyd of iron —	3,2
Water — —	2,25
(Loſs) — —	1,05
	100,00

† Cit. Lomel has diſcovered a quarry of ſuch ſtones at Saintrailles, in the department of Lot et Garonne, which have been employed with ſucceſs for building under water.

When

When this mixture has been well calcined and cooled, it is to be kneaded into the confistence of a soft paste with sixty parts of silex.

In the laboratory of the Polytechnic school a ball is preserved, which was made of mortar prepared in this manner, and according to the above-mentioned proportions, at the sitting of the 29th Pluviose, year 5, which was immediately thrown into water, where it hardened and acquired a specific weight of 2.231.

We may also procure very good artificial poor lime, at a smaller expence, by mixing with common quick-lime a certain quantity of what are commonly termed the white-iron ores, which are found in sufficient abundance, and are in a great measure composed of manganesiated carbonate of lime, especially such of them as are poor of iron.

It is possible, as *Saussure* has observed in his travels in the Alps, that there may exist stones, which, though they contain no manganese, yield nevertheless a lime susceptible of hardening in water, which may depend upon some other composition, such as that of the *Cendrée de Tournay*, the mortar made with the *Terrass* of the Dutch, &c. This, however, by no means invalidates the results drawn from the observations and experiments that have been made on the properties of the oxyd of manganese, which are of such efficacy, that a mortar which, without this addition, would immediately be liquefied in the water, hardens very speedily in it, provided there enter into its composition a certain quantity of this substance. Mr. Smeaton furnishes us here with an important observation, namely, that balls, made of lime and sand well kneaded together, are de-

ſtroyed by plunging them into water, whatever may have been the proportions of the mixture.

Of Beton, *or Water Cement.*

The name of *Beton* is applied in France to every compoſition of mortar that is intended to keep out water, or to be uſed in works under water, and which is ſuſceptible of becoming almoſt inſtantaneouſly ſolid.

Beton may be prepared in various ways. 1. The mortar of Loriot, when well prepared, holds water very well; I have uſed it for plaſtering the interſtices between the ſlabs of a terrace, and not the ſmalleſt filtration took place. I keep a maſs of this mortar formed into the ſhape of a vaſe, which, when filled with water, and placed upon a ſheet of paper, does not leave upon it any perceptible traces of humidity.

2. The mortar of Lafaye does not harden with equal rapidity; but when once it has become ſolid, it holds water very well without growing ſoft.

3. The mortar, of which Mr. Smeaton ſpeaks, made with equal parts of lime and terraſs, is a real beton, or water cement, as it may be uſed in the water without becoming ſoft.

4. The mortars compoſed with Pozzolana may alſo be uſed in the water, and when once they have become hard, they are ſuperior to all others in durability and reſiſtance to the motions of the water.

The moſt common kind of water cement, is that which is made with poor lime. It is formed into priſms of hard paſte, which are ſunk into the water to form a wall; or it is poured into a ſpace (21 or 22 decimeters in breadth), between two walls,

walls, in the manner of coffer-work, intended to confine the water in thoſe parts of canals that are elevated above the ground.

Means of procuring Subſtitutes for Pozzolana.

Pozzolana is a volcanic ſand, found in the vicinity of Naples. Though the ſuperiority of the mortars prepared with this ſubſtance is ſufficiently eſtabliſhed, we are frequently obliged to diſpenſe with it, on account of the high price which it bears, in conſequence of the charges of conveyance. There have, however, been diſcovered in France many extinguiſhed volcanos, which afford ſubſtances in abundance, whereby the place of Pozzolana may be ſupplied. The experiment has been made in the year 1787, by Cit. Ceſſart, the engineer, who was entruſted with the conſtruction of the cones of Cherbourg. In the month of Auguſt of that year I ſent to him about 13 kilogrammes of baſaltes, procured from the extinguiſhed volcano of Drevin, in the department of Saône-et-Loire.

The baſaltes had firſt been heated in a ſmall reverberatory furnace, then thrown red-hot into water, pounded, and paſſed through a ſieve, ſo that the largeſt grains did not exceed the ſize of a pea. The following are the reſults of experiments made upon the beton prepared with baſaltes, compared with betôn of Italian pozzolana, as tranſmitted to me by Cit. Ceſſart, in a letter, dated Feb. 12, 1788.

“ In order accurately to aſcertain the tenacity “ of this cement, I directed moulds to be made “ 6 inches long, 6 wide, and four deep, with “ which ſmall bricks of 144 cubic inches were “ formed.”

" *Compoſition of the cement.* It was compounded " of 180 cubic inches of baſaltes, 73 of flaked " lime, *(fuſee à la romaine,)* 93 of ſpring water, " 288 of granite, broken into pieces of the ſize of a " nut; the whole forming a cube of 534 inches."

" Two moulds were filled with this beton, " each mould being of the capacity of 144 cubic " inches. Of theſe maſſes I kept one immerſed " in the ſea for the ſpace of 76 days, and the " other remained expoſed to the atmoſphere for " the ſame ſpace of time."

" In order to aſcertain the tenacity of this " compoſition, the extremities of theſe maſſes " were placed upon the edge of a piece of iron, " and each was loaded with a kind of wooden " trough, narrow at bottom, and which was gra- " dually loaded with balls of lead."

" The ſame operation being performed on two " ſimilar bricks, with the ſame proportion of " Italian pozzolana in their compoſition as the " others had of baſaltes; that which had alſo re- " mained 76 days in the ſea, ſupported a weight " of 123 lbs. before it broke; and the piece " which had been expoſed to the atmoſphere for " the ſpace of 76 days, broke under a weight of " 71 lbs."

" All theſe proportions (Cit. Ceſſart obſerves) " are infinitely too ſmall for eſtabliſhing an exact " ratio; nevertheleſs, we are authorized to con- " clude, *That the baſalt-pozzolana of Burgundy* " *is nearly equal in quality to that of Italy, which* " *is ſent to us by way of Toulon.*"

In the ſame letter, Cit. Ceſſart requeſted of me to ſend him ſix thouſand-weight of this baſalt, in order that he might repeat his experiments on a larger ſcale. This, however, I was prevented from doing by the difficulties and expences of the conveyance:

conveyance; which would no longer be an obſtacle now that the navigation of the canal of Saône-et-Loire is completely open. The extinguiſhed volcano of Drevin is not quite a myriametre diſtant from the canal.

Another ſubſtance ſtill more common than baſalt, which might ſometimes be uſed as a ſubſtitute for pozzolana, is the aſhes of pit-coal, provided the coal be of a heavy bituminous nature, leaving rather ſcoria than aſhes after its combuſtion.

I ſent alſo ſome of this ſpecies to Cherbourg, in the year 1787, under the name of *light pozzolana*, to diſtinguiſh it from that prepared from baſaltes. It was ſubjected to the ſame comparative experiments, the reſult of which is related as follows, in a letter of Cit. Ceſſart.

" The bricks that had remained expoſed to the
" atmoſphere for a ſpace of 76 days, ſupported
" weights of 115 and 137 lbs. before they
" broke."

" Similar pieces, that had been immerſed in
" the ſea alſo for the ſpace of 76 days, broke
" under weights of 38 and 40 lbs.; conſequently
" they had loſt their conſiſtence in the ſea-
" water."

It is evident that mortar made with this kind of aſhes has a decided ſuperiority over that made with Italian pozzolana, for dry erections, its tenacity being almoſt double. It cannot, it is true, be employed under water, like the cement made from poor lime; but it is probable that it would ſucceed very well in works conſtructed in dry ſituations, to which the water might be prevented from finding acceſs, till it had acquired a proper conſiſtence.

It was with this view that I recommended this preparation to be uſed, in conſtructing the inner walls of the locks and baſins of the canal of Saône-et-Loire, which were preciſely in this condition, and near to which there were large collections of this ſubſtance, produced by the fires of glaſs-houſes.

Addition.

Cit.ⁿ Monge, who has viſited the ruins of Cæſarea, of which the hiſtorian Joſephus gives ſo pompous a deſcription, has aſſured me, that one might diſtinguiſh in theſe ruins, by the ſtyle of the architecture and the ſolidity of the cements, the different ages of the original ſtructures, as well as of the works ſucceſſively added to them, after the invaſion of the Arabs, and during the cruſades.

He obſerved on the other ſide of the haven, which is now filled up, the remains of a temple conſecrated to Auguſtus: the front wall had been attempted to be ſupported by counterforts, which ſtill remained, and in ſeveral parts of which mouldings and ornaments were to be ſeen, of exquiſite taſte, formed by the mortar that had attached itſelf upon relievos which now no longer exiſt.

The original ſtone of the ſtructure had been worn away to a great depth, and the mortars formed projections from it.

He endeavoured to break off a piece of this mortar, but was not able; it was of a very fine and even grain, and appeared to be compoſed of a very fine ſand with very little lime, but well mixed.

XXIII.

XXIII. *Lift of Patents for Inventions, &c.*

(Continued from Page 72.)

HENRY TICKEL, of Manfel-ftreet, White-chapel, Middlefex, Brewer; for an apparatus or refrigerator for more fpeedily and effectually cooling the worts, and other fermented, ferment-able, or other liquors, or melted or diffolved animal or vegetable fubftances, manufactured, made, or ufed, by, or in the proceffes of, brewers, dif-tillers, vinegar-makers, foap-makers, fugar-refiners, chemifts, or other manufacturers of articles of a fimilar nature, or ufing fimilar proceffes. Dated May 2, 1801.

JOHN EDWARDS, of Chelfea, Middlefex, Gentleman; for new-invented collars for horfes, on an improved conftruction. Dated May 2, 1801.

WILLIAM PRITCHARD, of Shrewfbury, Salop, Hatter, and THOMAS WILLMORE, of Birmingham, Warwickfhire, Japanner, for an article for the ufe of hats, foldiers caps, helmets, &c. Dated May 2, 1801.

BARKER CHIFNEY, of the city of London, Gentleman; for an improved method of preparing and laying diamond and other flates in covering houfes and other buildings, and for preparing flates for other purpofes. Dated May 2, 1801.

JOSEPH CHIRM, of Birmingham, Warwick-fhire, Pump-maker; for a machine, on an improved conftruction, for the purpofe of boring timber for water-pipes, and other purpofes. Dated May 12, 1801.

EDWARD

Edward Walker, of Rathbone Place, Middlesex, Vintner; for a portable ſtove or kitchen, for the purpoſe of dreſſing and cooking victuals. Dated May 12, 1801.

William Hase, of Saxthorpe, Norfolk, Engineer; for a ſteam-engine on an improved conſtruction, by which a conſiderable reduction will be made in the conſumption of coals. Dated May 14, 1801.

Sebastian Erard, of Great Marlborough-ſtreet, Weſtminſter, Middleſex, Muſical Inſtrument-maker; for improvements in the conſtruction of harps and piano fortes. Dated May 16, 1801.

Walter Inglis, of Chelmsford, Eſſex, Sadler; for a method of forming and making a ſaddle upon a new and improved conſtruction. Dated May 21, 1801.

James Glazebrook, of Coalbrook Dale, Salop, Engineer; for his further improvements upon the methods of working and giving power to machinery by means of the properties of airs; which methods were originally invented by him, and for which he obtained former letters patent. Dated May 21, 1801.

Thomas Bagnall, of Worſley, Lancaſhire, Gentleman; for a mill or machine to chop bark, and grind, and riddle, and pound it. To beam or work green hides and ſkins out of the maſtering, or drench, and make them ready and fitting for the ouſe or bark liquor. To beam ſheep ſkins, and other ſkins, for the ſkinners uſe, and for ſcouring or taking the bloom off or from tanned leather when in the currying ſtate. Dated May 21, 1801.

Printed by Nichols and Son, Red-Lion-Paſſage, Fleet-Street, London.

REPERTORY OF ARTS AND MANUFACTURES.

NUMBER LXXXVII.

Printed by NICHOLS and SON, Red-Lion-Paſſage, Fleet-Street, London.

XXIV. *Specification of the Patent granted to Mr.* THOMAS BAGNALL, *of Worſley, in the Pariſh of Eccles, in the County of Lancaſter, Gentleman; for a Mill or Machine to chop Bark, and grind, and riddle, and pound it; to beam or work green Hides and Skins out of the Maſtering or Drench, and make them ready and fitting for the Ouſe or Bark Liquor; to beam Sheep Skins and other Skins, for the Skinner's Uſe, and for ſcouring and taking the Bloom off or from tanned Leather when in the currying State.* Dated May 21, 1801.

WITH A PLATE.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with the ſaid proviſo, I the ſaid Thomas Bagnall do hereby declare, that my ſaid invention is deſcribed in manner following: that is to ſay;

Fig. 1, (Plate VIII.) is a horizontal plan of the mill. Fig. 2, longitudinal ſection of it. Fig. 3, tranſverſe ſection of it.

A. The water-wheel, by which the whole machinery is worked.

B. The ſhafts.

C. The pit-wheel, which is fixed on the water-wheel ſhaft B, and turns the upright ſhaft E, by the wheel F, and works the cutters and hammer by tapets.

D. The ſpur and bevil-wheel at the top of upright ſhafts.

E. The upright ſhaft.

F. The crown-wheel, which works in the pit-wheel C.

G. The ſpur-nut to turn the ſtones I.

P. The beam, with knives or cutters fixed at the end to chop or cut the bark, which ſaid bark is to be put upon cutters or grating *i*, on which ſaid beam is to fall.

Q. The tryal that receives the bark from the cutters *i*, and conveys it into the hopper H, by which it deſcends through the ſhoe J to the ſtones I, where it is ground.

K, The ſpout, which receives the bark from the ſtones, and conveys it into the tryal L, which tryal is wired to ſift or dreſs the bark, as it deſcends from the ſtones I.

M The trough to receive the bark that paſſes through the tryal L.

S. A kind of diſh, to receive that part of the bark which does not paſs through the tryal L.

R. The hammer, to cruſh or bruiſe the bark that falls into the diſh S, which ſaid diſh is on the incline, ſo that the hammer keeps forcing it out of the lower ſide of the ſaid diſh, when bruiſed.

k. A trough to receive the duſt and moſs that paſſes through the tryal Q.

T. The

T. The bevil wheel, that works in the wheel D, which works the beam-knife by a crank V at the end of the ſhaft *u*.

W. The penetrating rod, which leads from the crank V to the ſtart *x*.

x. The ſtart, which has ſeveral holes in it to lengthen or ſhorten the ſtroke of the beam-knife.

y. The ſhaft, to which the ſlide rods *b*, *b*, are fixed by the ſtarts *n*, *n*.

b. The ſlide rod, on which the knife *f* is fixed; which ſaid knife is to work the hides, &c. On the knife are two ſprings *a*, *a*, to let it have a little play as it makes its ſtroke backwards and forwards, ſo that it may not ſcratch nor damage the hides, &c.

z. Is a catch in ſlide-rod *b*, which catches on the arch-head *e*; and the ſaid arch-head conveys the knife back without touching the hide, and and then falls back to receive the catch again.

l. The roller to take up the ſlide-rod *b*, while the hides are ſhifting on the beam *b* by pulling at the handle *m*.

b. The beam to work the hides, &c. on. Each beam has four wheels *p*, *p*, working in a trough road *g*, *g*, and moved by the levers *c*, *c*. When the knife has worked the hide, &c. ſufficiently in one part, the beam is then ſhifted by the lever *c* as far as is wanted.

d. A preſs, at the upper end of the beam, to hold the hide faſt on the beam while working.

e. An arch-head, on which the ſlide-rod *b* catches.

f. The knife fixed on the ſlide-rod *b*, to work the hides, &c.

i. Cutters or grating to receive the bark for chopping.

 The

The beam P, with knives or cutters, may either be worked by tapets, as deſcribed, or by the bevil-wheel T, with a crank, as V, to cut the ſame as ſhears.

The knife *f* is fixed at the bottom of the ſtart, which is fixed on the ſlide rod *b*; the bottom of the ſtart is ſplit open to admit the knife, the width of one foot; the knife ſhould have a gudgeon at each end, to fix in the open part of the ſtart; and the two ſprings *a*, *a*, prevent the knife from giving too much way when working; the knife ſhould be one foot long and four or five inches broad.

The arch-head *e* will ſhift nearer to, or farther from, the beam *b*, and will be fixed ſo as to carry the knife back as far as is wanted, or it may be taken away till wanted.

The roller *l* is taken up by pulling at the handle *m*, which takes up the ſlide-rod ſo high as to give head-room under the beam-knife. The handle may be hung upon a hook for that purpoſe. The ſlide-rod will keep running upon the roller all the time the hide is ſhifting; and when the hide is fixed the knife is put on the beam again by letting it down by the handle *m*. There may be two or more knives at work on one beam at the ſame time, by having different ſlide-rods. There ſhould be two beams, ſo that the workman could be ſhifting one hide, &c. while the other was working. The beam muſt be flat, and a little on the incline. As to the breadth it does not matter, the broader it is the leſs ſhifting of the hides will be wanted, as the lever *c* will ſhift them as far as the width of the hide, if required. I have formed a kind of preſs *d*, to let down, by a lever, to hold the hide faſt on each ſide of the

Fig. 1.

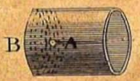


Fig. 2.

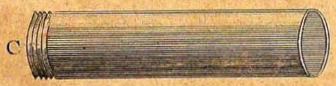


Fig 3

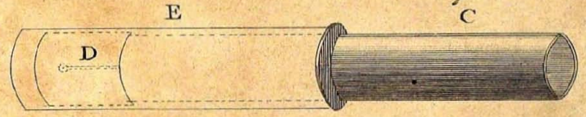


Fig 4.

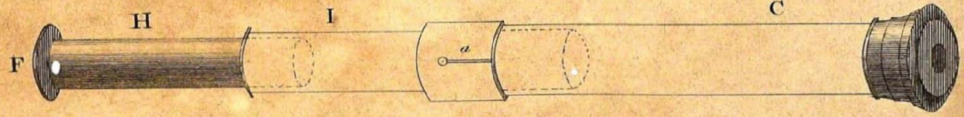
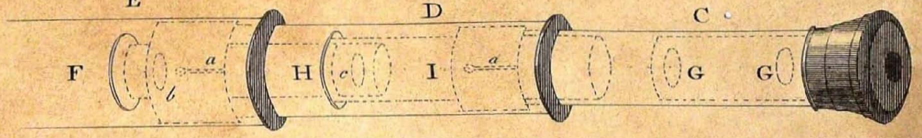


Fig 5.



the knife if required, ſo that it will ſuffer the knife to make its back ſtroke without pulling the hide up as it comes back. The ſlide-rod may be weighted, to cauſe the knife to lay ſtreſs on the hide, &c. according to the kind and condition of the goods to be worked.

Hides and ſkins for the ſkinners' uſe are worked in the ſame way as for the tanners.

Scouring of tanned leather for the curriers' uſe will be done on the beam the ſame as working green hides. It is only taking the knife away, and fixing a ſtone in the ſame manner as the knife by the ſaid joint, and to have a bruſh fixed to go either before or after the ſtone. The leather will be better ſcoured this way than by hand, and much ſooner.

N. B. The whole machinery may be worked by water, wind, ſteam, or any other power. And that part of the machinery which relates to the beaming part of the hides, may be fixed to any horſe bark-mill, or may be worked by a horſe or other power ſeparately.

The intention of working hides and ſkins upon the beam is to clean, and get out of them all the lime and dirt that can be got out, which is the principal part of the buſineſs for making good leather; the dirt will be got out much better, and the hides be made cleaner this way than they can by hand, and at much leſs expence.

In witneſs whereof, &c.

XXV. *Specification of the Patent granted to Mr.* JOHN TURNBULL, *Junior, of Cordale Printfield, in the County of Dumbarton, North Britain, Calico-printer; for certain new Proceſſes or Improvements of Proceſſes and Apparatus applicable to the bleaching or whitening, and to the purifying, waſhing, and cleanſing of Cotton, Flax, Hemp, Silk, and Wool, and alſo applicable to the bleaching or whitening, and to the purifying, waſhing, and cleanſing, of Goods of every Deſcription made or manufactured of Cotton, Flax, Hemp, Silk, and Wool, or of Mixtures of all or any of the above Materials, and to other Purpoſes, by which a conſiderable ſaving will be effected in the Expence of Fuel, Alkali, and other Matters or Things employed in bleaching or whitening, purifying, waſhing, and cleanſing Goods and Apparel of every Deſcription.* Dated November 15, 1800.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that I the ſaid John Turnbull, in compliance with the ſaid proviſo, do hereby deſcribe and aſcertain the nature of my ſaid invention, and in what manner the ſame is to be performed; *videlicet*, I take cotton, flax, hemp, ſilk, or wool, or goods of any deſcription made or manufactured of cotton, flax, hemp, ſilk, or wool, or of mixtures of all or any of the above materials that are wiſhed or intended to be bleached or whitened; and firſt cleanſe, waſh, or purify them from the looſe dirt and foreign matter that may be adhering to them, or mixed in their texture, as alſo from the paſte, or other dreſſing, that may have been uſed in their manufacture,

ture, (when the article or articles to be bleached or whitened are in a manufactured ſtate); which waſhing, cleanſing, or purifying, I effect by any of the common proceſſes uſually known and followed; as by ſteeping them in water, either hot or cold, or in any convenient aqueous ſolution, for about twelve hours, more or leſs, according to the quantity and quality of the goods, and afterwards mill-waſhing them, or otherwiſe cleanſing them from ſuch impurities or dirt as can be removed by this or any ſimilar means. By this waſhing, cleanſing, or purifying, the goods are brought into a ſtate more fit for the application of my new method of bleaching or whitening than if ſubjected to it, (which they may alſo be,) without that previous cleanſing. When thus cleanſed, they are put into a lye of vegetable or of mineral fixed alkali, or the volatile alkali, either mild, or made cauſtic by quick lime, or into a lye of quick lime only, or into a ſoapy lye, or into a lye compoſed of all or any of theſe ſubſtances, (with or without the addition of oxygenated muriatic acid,) of a ſtrength fit for the purpoſe of extracting the coloured or colourleſs gummy reſinous or other impurities which may exiſt naturally in, or which may have been introduced (by accident or deſign) into the fibre or texture of the materials or goods under proceſs, and which are too intimately united with them to admit of being removed by the firſt above-deſcribed waſhing or cleanſing. The alkaline, ſoapy, or other lye, may be prepared by the method or methods uſually followed by bleachers; my invention not conſiſting in the kind of alkaline lyes, or other liquors employed, or in the way of preparing them, but in the mode

of

of applying ſuch alkaline, ſoapy, or other lyes, and in the accompanying and ſubſequent manipulations; for, when the goods or articles to be bleached are immerſed in the alkaline, ſoapy, or other lye or liquor, as before directed, inſtead of boiling or bucking them in it, as is the practice uſually followed, I only ſteep them, or keep them long enough in the ſaid lye to be thoroughly impregnated with it, which requires a ſhorter or longer time, according to the quantity and texture of the articles or goods. The goods are then drawn out of the rack over the veſſel in which they were impregnated, and ſuffered to drain, that the ſuperficially adhering lye or liquor may run from them back into the veſſel. After this draining, the goods ſtill hold a ſufficient quantity of the lye or liquor employed to anſwer the end in view. They are then put into a veſſel of ſufficient ſtrength and dimenſion made of wood, ſtone, brick-work, earthen-ware, metal, or any proper material. This veſſel, which I call a ſteaming-vat, may be almoſt of any form convenient for the premiſes or place where it is to be fixed, and is connected by means of a pipe, tube, hoſe, trunk, or hollow priſm, made of wood, metal, or of any fit material, with a boiler, kettle, or cauldron, which I call the ſteaming kettle, and which may be of any convenient form and dimenſions. The tube above mentioned may paſs from any part of the edge or of the ſide of the ſteaming kettle, or even from its cover, which ought to fit ſteam-tight, into any part of the ſide or bottom of the ſteaming vat, the intention and uſe of it being to convey ſteam from the aforeſaid kettle to the aforeſaid vat. The tube, pipe, hoſe, trunk, or hollow priſm, is furniſhed with a ſtop-

cock

cock or valve, or any contrivance that will anſwer the purpoſe of ſhutting and opening at pleaſure the communication between the ſaid kettle and vat. The ſteaming vat ought, for the convenience of lifting out the goods, to be furniſhed with a falſe bottom of ſome kind, in the inſide, as of wood or of net-work, for the goods to lie upon; and to this falſe bottom ſhould be attached ropes, by means of which, and the aſſiſtance of a crane and pulley, or any other convenient mechanical power, the goods may be withdrawn from the vat after the operation of ſteaming them. The operation of ſteaming the goods is performed by opening the communication between the ſteaming kettle and ſteaming vat; the former, which contains ſome water or aqueous ſolution, being kept at a proper heat by means of a fire put under it, and the latter having previouſly its cover fitted on ſteam-tight. The ſteam is thus, as it were, pent up in the kettle and vat, and made to act with any preſſure that may be deſired, or that the ſtrength of the veſſels may be able to ſuſtain. To ſecure the ſafety of the people employed, the apparatus ought always to be furniſhed with a ſafety-valve attached to any part of the ſteaming kettle, or of the ſteaming vat, or of the tube of communication, that when the elaſtic force of the encloſed ſteam reaches the determined point, the valve may open of itſelf, and allow a portion of it to eſcape. By this proceſs the goods can be heated conſiderably above the boiling point, a circumſtance that adds ſo much to the diſſolving power of the alkaline, or ſoapy, or other lye, that the quantity left in the goods, after draining, as before deſcribed, is found ſufficient to diſſolve and diſcharge, by one ſteam-

ing, as much of the reſinous, gummy, or other impurities, from the goods under proceſs, as could have been diſcharged by a long boiling of the goods in the lye itſelf, as is the uſual practice, and by this means a great ſaving is made in the alkalies or other ingredients employed for whitening the goods. For, in the common method, the colouring matter, as diſcharged from the fibre or texture of the goods, is diffuſed throughout the whole lye, which ſoon renders it ſo foul that it is obliged to be changed long before it has become ſaturated with the ſubſtances or matters on which it exerciſes its power. But by my proceſs or proceſſes there is no more lye employed for one ſteaming than what is ſufficient merely to impregnate the goods thoroughly; and the alkali thus depoſited in the texture or fibre of the goods under proceſs is more or leſs diſengaged from the ſaid texture or fibre by the action of the ſteam, and is found at the bottom of the ſteaming vat, of a dark colour, occaſioned by the matters it has diſſolved, and carried down with it. The ſteaming vat may be very commodiouſly freed from this depoſit by a common ſtop-cock, or even a plug at or near its bottom, to be opened as often as it may be neceſſary. I alſo effect the ſame end by uſing only a deep boiler, with a ſteam-tight cover, ſuſpending the goods previouſly impregnated with the alkaline or other lye, as before directed, on frame or net work, over boiling water, in the ſaid boiler, and employing oxygenated muriatic acid, acidulated waters, till waſhing, or expoſure to the ſun and air, when theſe are neceſſary: particular care muſt be taken to keep a ſupply of water, or ſome aqueous ſolution, in the lower part of the boiler, below

below the frame or net work on which the goods lie, or otherwiſe they may be ſinged, or actually burnt, and a loſs be actually incurred. But I prefer putting the goods into ſteaming vats, to putting them in a boiler, in the manner juſt deſcribed, and that on ſeveral accounts, but eſpecially becauſe, by means of one ſteaming kettle, ſteam can be thrown into as many vats as can conveniently be ranged round it, which is a mean of making a conſiderable ſaving in the article of fuel. One ſteaming generally requires from four to eight hours, but the length of time will vary according to the kind or quality of the goods to be whitened, and the ſtrength of the lye that has been employed for impregnating them. After the ſteaming has been continued a ſufficient length of time, the cover of the ſteaming vat is taken off. The communication with the ſteaming kettle is cut off by means of the aforeſaid cock or valve, provided for that purpoſe, and the goods are lifted out by means of a crane and pulley, or other fit mechanical power, as before mentioned. They are then well waſhed by milling, or by any of the proceſſes followed by bleachers. After this they are again impregnated with lye, ſteamed, and then waſhed; and theſe manipulations are repeated in the manner that has already been deſcribed till the goods are brought to the required degree of whiteneſs and purity. The uſual operations of ſteeping in acidulated waters, and expoſure to the ſun and air, or to the action of the oxygenated muriatic acid, in ſuch ſtages of the proceſs as the bleacher may think proper, may be employed with advantage in my method, as well as in the common and uſual method of bleaching. I need hardly

 direct

direct here, what every bleacher's own experience muſt point out to him, namely, that when acidulated waters, expoſure to the ſun and air, or the oxygenated muriatic acid, are to be employed after any ſteaming, the goods ſhould firſt be waſhed. When ſilk, ſheep's wool, or goods containing ſheep's wool or animal hair, or fur, of any kind, are wiſhed to be cleaned, ſcoured, or whitened, by the above-deſcribed method, the lye employed ought to be much weaker than in the caſe of cotton, flax, or hemp, or of goods manufactured of theſe, or any of them; for a ſtrong cauſtic lye would entirely deſtroy the former, and convert them into a ſaponacious matter. In witneſs whereof, &c.

XXVI. *Specification of the Patent granted to Mr.* DUDLEY ADAMS, *of Fleet-ſtreet, in the City of London, Optician; for his Invention of a Mode of rendering Teleſcopes, Perſpective, Proſpect, and other Optical Glaſſes more portable.*

Dated May 30, 1800.

WITH A PLATE.

To all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that I the ſaid Dudley Adams, in purſuance of, and compliance with, ſuch proviſo, in the ſaid recited letters patent contained, do, by this inſtrument, under my hand and ſeal, particularly explain and deſcribe the nature of my ſaid invention, and the manner in

in which the ſame is to be performed, by the drawings, references, and explanations, herein contained and ſet forth; that is to ſay: The principle and utility on which my new invention on teleſcopes, perſpective, proſpect, and other optical glaſſes, is founded, is in rendering them, by this new conſtruction, conſiderably more portable than they have hitherto been made. In order to produce the peculiar degree of portability that has been effected, it was found expedient to adopt a new ſpecies of ſpring, that would, from its principle and conſtruction, occupy the leaſt poſſible ſpace, and at the ſame time render the teleſcopes, to which it was applied, ſtrong and ſteady when drawn out. This was the more neceſſary, as, according to the new conſtruction, the number of joints or tubes would be augmented conſiderably beyond the number hitherto employed. It was neceſſary alſo to deviſe ſome means by which the ſeveral glaſſes, applied to the eye-ends of teleſcopes, ſhould acquire their true poſitions and diſtances when the joints or tubes were drawn out, after having been compreſſed into a ſmall ſpace, and the ſame be retained in every ſituatoin wherein they might be placed by the obſerver during the time the teleſcope was being adjuſted for uſe.

Reference to Plate IX.

Fig. 1. A, repreſents the form and conſtruction of the ſpring. It conſiſts of a thin piece of metal tube, turned in a lathe ſtrictly true and cylindrical, and to fit the inſide of the drawer or

tube

tube in which it is intended to ſlide. It is then ſlit down, from the open end, in two, three, four, or more places, to give it elaſticity: this latter circumſtance is not however abſolutely neceſſary. The dotted lines at B repreſent the under-ſide of the ſpring perforated, in which a ſcrew is cut, of the ſize to ſcrew on the end of the tube at C, Fig. 2, and made faſt there.

This inverted cylindrical ſpring, ſimple as it is in its conſtruction, affords all the advantages neceſſary; it occupies leſs ſpace than the ſprings hitherto adopted, and by that means admits of more drawers, tubes, or joints, being added than could, according to the former mode, be uſed or applied within the ſame ſpace; by its cylindrical form, that ſtrength and ſteadineſs is obtained, which is ſo eſſential to the conſtructing a good teleſcope with drawers. It preſerves the axis therefore as one uninterrupted line, in every poſition of the drawers, whether they are drawn out to the fulleſt extent, or returned in part into their ſeveral tubes. It is alſo of ſuperior advanvantage, and the beſt adapted to the conſtruction of plated teleſcopes, whether plated in gold or ſilver, or whether the drawers or tubes are lacquered, painted, or japanned, &c. as by its action and principle all preſſure and friction on their poliſhed, plated, or painted ſurfaces, may be obviated, and the poſſibility of thoſe ſurfaces being rubbed, ſcratched, or worn, thereby totally prevented. Fig. 3, repreſents the tube C with the ſpring thereon at D. E, repreſents the tube in which it ſlides.

The ſecond part of the invention is effected in the following manner. Fig. 4, C, repreſents the

tube

tube called the eye-tube, or that which is placed next the eye when the teleſcope is being uſed. *a*, the ſpring thereon. H and I, two tubes, that are made to ſlide into the interior of the tube C. F, a broad circular plate, ſhoulder, or flaunch. To explain the action and principle of the tubes H and I more fully, another figure, *viz.* Fig. 5, has been given. C, repreſents the tube to be placed next the eye. *a*, the new-invented cylindrical ſpring thereon. D, the next tube, in which the ſaid ſpring ſlides, provided alſo with its ſpring *a*, which ſlides in the third tube E. The firſt and ſecond glaſſes are contained in the eye-tube C, and are repreſented by dotted lines G, G. The third and fourth glaſſes are inſerted in the tube H at *b c*. Theſe tubes, as have been mentioned, are made to ſlide into the interior of the eye-tube C, when the inſtrument is cloſed, but when the tubes are drawn out, they will have nearly the effect repreſented. For when the tubes C, D, and E, are drawn out, the flaunch F will ſtrike againſt the end of the tube D, and by that means the two tubes H and I will alſo be drawn out, and will retain their preſent poſition until all the tubes are nearly cloſed. For it is not until the flaunch F reaches one of the laſt tubes, that the two tubes H and I will be forced into the tube C. The glaſſes therefore contained in them will acquire and retain their true diſtances while being uſed.

The advantages of this part of the invention need not be enlarged upon, as will appear obvious to every one who conſiders the ſubject, that by means thereof, together with the new ſpring, the utmoſt portability in teleſcopes may be effected,

fected, and their length in consequence be considerably extended beyond what is usually adopted if necessary.

The same degree of portability, and any degree of length, may be obtained by the addition of three, four, or more tubes, in the place of the two already mentioned; and the tube containing the first and second glasses might be constructed after the same manner, *viz.* to consist of two, three, or more tubes, and made to slide one within the other; and in some instances, where the telescopes are very long, one tube might be made perhaps to answer the purpose. These and other similar modes might hereafter be adopted without altering the principle of this invention, which establishes a rule whereby the several glasses at the eye-ends of telescopes may, from the manner in which they are placed, be brought near to each other, and afterwards placed at their proper distances, without inconvenience or prejudice to the telescope. Of the many modes that have been tried and named herein, the particular one adopted has been preferred; it is the most simple, and it moreover possesses all the advantages required. In witness whereof, &c.

XXVII.

Fig. 1.

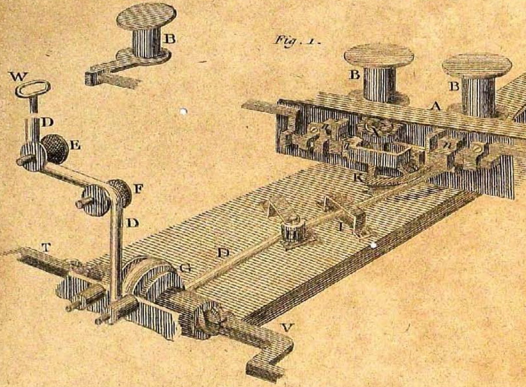


Fig. 2.

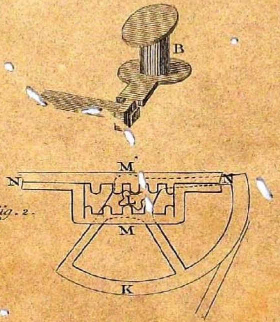


Fig. 5.

Fig. 3.

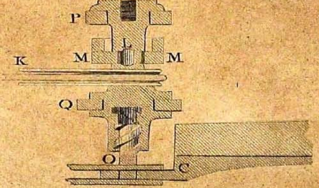
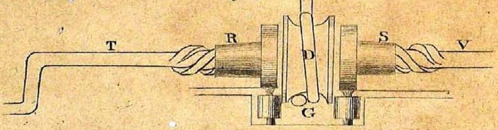


Fig. 4.



XXVII. *Specification of the Patent granted to Mr.* THOMAS ROBERT GUEST, *of Portſmouth*, in the County of Hants, Artiſt; for his Invention of certain Boxes, of a new and improved Conſtruction, of various Forms and Sizes, to contain certain new and improved Materials, and other neceſſary Articles for drawing and painting; likewiſe an entire new and improved Method of arranging, on ſcientific Principles, the Colours to be contained in the ſaid Boxes.* Dated June 2, 1801.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that I the ſaid Thomas Robert Gueſt do hereby declare, that my ſaid invention of a new box or boxes, and materials, for painting and drawing, and my new manner of arranging the pallet of colours, and certain new materials that are to be contained therein, by which the art of drawing or painting in colours will be rendered more ſimple and generally uſeful, is deſcribed as follows.

The boxes, of whatever ſize or ſhape, or material they may be made, are to be ſo formed as to contain, with convenience, either a round, or ſquare, or oval, or any other ſhaped piece of marble, or wood, or metal, or ſtone, or porcelain, or pottery, or glaſs, or other proper material or compoſition, or combination of materials of any kind, either coated or plain, which piece of marble, or wood, or metal, or ſtone, or porcelain, or pottery, or glaſs, or other material, is *abſolutely neceſſary for or to* my new arrange-

* Mr. Gueſt has alſo a houſe in London, No. 82, Pall Mall.

ment of the pallet of colours, and which I ſhall hereafter, in this ſpecification, call by the name of a *pallet of colours.* And the box or boxes will be made ſubſervient to it, and ſo contrived, that this *pallet of colours* will be ſometimes fitted in the top or cover, or in a drawer, either in the front, end, or ſide, or ſome other convenient place, for the purpoſe of receiving it, but in ſuch a manner that this *pallet of colours* may be eaſily removed, if wanted for uſe, by the artiſt or perſon drawing or painting; and that the colours are to be arranged or fixed on, or let into it, by certain places being made or ſunk into the pallet to receive them; and theſe places will ſometimes be of a long ſquare, or of an oval or a round, or indeed any other ſhape that may be found beſt adapted for the purpoſes intended, by which means the colours are guarded from all dirt or duſt, they cannot be miſplaced, the artiſt has no occaſion to apply to a plate or other material to rub his colours on when uſed, the pallet on which they are arranged and fixed ſerving for that purpoſe, and which may be eaſily cleaned, when neceſſary, with a damp ſponge. The colours are to be fixed, or let into the pallet, ſo as not to be removed, or to fall out, which is done by firſt caking them in the uſual manner, and afterwards faſtening them in, while damp, by ſome mucilaginous mixture, ſuch as gum-water, or any other that will not injure them. It is hardly neceſſary to obſerve, that of whatever material the pallet be made, it ſhould be preſented in an unglazed or unpoliſhed ſtate: thus, if made of marble or other ſtone, it ſhould be left as ſmooth as poſſible, but unpoliſhed. If of wood, it muſt be coated with a compoſition of oil, flake white, and calx of tin, or

or any other compofition that will anfwer the purpofe of refifting the penetration of water, and left as fmooth as poffible, but not polifhed nor glazed. If of metal, it fhould be enameled, and ground fmooth, but left with a tooth, and without polifh. If of porcelain, to be left in the bifcuit ftate. If of glafs, it fhould, in the vitrification, be mixed with the calx of tin, or any other material that will make an opaque white enamel of it, and when made of the proper fhape it fhould be ground, and left without polifh. Let it be obferved, that I do not wifh to ftate that the colours may not be mixed on glazed or polifhed fubftances, but unglazed and unpolifhed bodies for that purpofe are much fuperior.

The convenience and utility of this *pallet of colours* every experienced and profeffional man will fee; and it will remove the inconvenience above mentioned, which the younger practitioners have hitherto laboured under. The colours will likewife be arranged, and fixed on or into the pallet, in the following order, according to the *principia optica, viz.* The three original colours, yellow, red, and blue, will be fixed on or into the pallet, and fo arranged as to fhew their intermediate fhades, *viz.* from yellow the degrees of orange to red; from red the degrees of purple to blue, with the different degrees of green and the browns refulting from a mixture of the three original colours: which arrangements will include every poffible tone or tint that can be prefented to the eye, and the colours and tints will be arranged on or in the pallet, fo that the numbers 1, 2, 3, &c. will indicate the tone or tint of each, and may be called yellow, orange, red, purple, blue, green, and brown, &c. without any reference to the original name of any

 particular

particular pigment or chemical preparation at preſent in uſe, unlike the preſent method, which by naming the pigment contrary to its real tone or colour, (though the experienced artiſt may remove the difficulties from himſelf,) ſerves only to miſlead the ſtudent; and thoſe not previouſly acquainted with the uſe of colours, without conveying any idea of the tone or tint of colour wanted, but by the above arranged pallet of colours the maſter is eaſed, the ſtudent improved, and a rational and ſimple theory will go hand in hand with the practical part. The colours in the larger boxes, and on the larger pallets, will likewiſe be divided into *tranſparent or glazing*, and *opaque or body colours*. The tranſparent being fixed on, or let into one ſide, and the opaque on or into the other ſide of the pallet, to prevent confuſion. And the tranſparent and opaque colours are to be arranged in the ſame manner with regard to the degrees of tone and ſituation, which will enable the artiſt to produce the effect he wiſhes, according to his ſtile or mode of practice with the opaque; and he may, by turning his pallet, inrich and glaze his painting with the tranſparent colours without rendering them foul or muddy. Having deſcribed the nature of my invention, as regards the boxes, and the *arrangement of the pallet of colours*, I will proceed to ſtate the means of rendering this invention ſtill more convenient to the publick, which conſiſts in adding to the boxes ſuch articles as will ſupply the artiſt with every utenſil and material that he can want, and thoſe of the beſt quality. In the larger boxes, capable of containing them, will be introduced the neceſſary varniſhes, with directions for their uſe; and as the uſual pallet knives, with blades compoſed of iron, ſteel, or ſilver, are very

very detrimental to the colours, even to the total deſtruction of ſome of them, as may be inſtanced in the pigment called Naples yellow, which is changed to a dirty greeniſh colour when rubbed or mixed with ſuch knives, a knife formed out of ſhell, or ivory, or horn, or wood, will be ſubſtituted in their ſtead. Camel, fitch, and ſable pencils, will be added as uſual, of an improved quality, with new pencils of cork. Pumice ſtone and ſponge, for raiſing out or producing the lights of waſhed drawings; port crayons, pencil racks, water glaſſes, and parallel rulers, will alſo be introduced into the ſaid boxes; but as the before-mentioned *pallets of colours* can be removed from the boxes above deſcribed, I *fix* them to thoſe intended for the army and navy in the moſt portable and convenient manner to carry in the pocket, to uſe as occaſion may offer; and in general they will not take up more room than a ſmall-ſized pocket or note book, and will be often made of that ſize and form, with only the three original colours, which are all that are wanted for navy ſignals; to theſe will be added brown and black to thoſe intended for the reconnoitring ſketchings of the army. The great advantage of which will be ſelf evident, as the colours and pallet are fixed, with room for the pencils and cards, the box or book may be ſhut, in the moſt hurried moment, without defacing or injury to the ſketch.

In addition to the advantages ariſing from the above-mentioned pallet of colours, &c. I have only to obſerve, that the colours will be of a very ſuperior quality in fineneſs, tone of colour, durability, and eaſe in the working. In witneſs whereof, &c.

XXVIII.

XXVIII. *Description of an Apparatus for preventing Passengers in Carriages being injured when the Horses have taken Fright.*

By Mr. George Davis, *of Windsor.*

WITH A PLATE.

From the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

A Bounty of Thirty Guineas was awarded to Mr. Davis *for this Invention.*

Having affixed the apparatus to a coach, I should conceive it would not be necessary to enter into a very particular description of it. I shall therefore only relate the manner of operation.

"It is fixed behind the splinter-bar, and the communication, by means of a copper chain, is carried through the boot to the side of the coach-box, that, in case of the horses taking fright, or, of that more fatal accident, the reins breaking, which precludes the possibility of stopping the horses, the coachman can discharge them instantaneously." There is this superiority in my invention over any other method hitherto put in practice, "That the horses can be liberated, even when the pole is at right angles, or locked close to the perch, a position which otherwise overturns a carriage." I have had the honour of exhibiting a trial before his Majesty, and discharged the horses three times; which Mr. Vidler,

ler, of Millbank, can atteſt, having been preſent on the ſpot, and who was pleaſed to ſay, that he thought, if it was more generally known, no carriage would be without it *.

Description of the Machine.

(See Plate X.)

Fig. 1, A, the ſplinter-bar of a carriage, to which the horſes are attached by the traces fixed to the rollers B, B, B, B, and to the pole C.

D D D, a braſs chain, extending from the coach-box to the ſplinter-bar: this chain goes under the roller E, over the roller F, is then wound once round the pulley G, and thence directed, by the ſmall rollers H and I to the quadrant K, to the fartheſt extremity of which it is attached.

The quadrant K has a vertical axis, on the upper part of which is a pinion with four teeth, (ſee L, Figs. 2 and 3). This pinion works in two racks, M, M, fixed on two elbow head bolt-bars N, N; and, by means of theſe racks, the bolts are moved backwards and forwards by the action of the quadrant K.

Theſe bolt-bars extend from the centre of the ſplinter-bar to its extremity, the ſtraight end of the bolts ſhooting into the rollers B, B, Fig. 1, at the end of the ſplinter-bar, and the elbow-heads, *n*, *n*, ſhooting into the two centre-rollers B, B.

On the lower part of the axis of the quadrant K is a female ſcrew, which receives a bolt O,

* In a letter to the ſecretary of the ſociety Mr. Vidler corroborates this ſtatement of Mr. Davis.

(ſee

(see Fig. 3,) one end of which, when bolted, passes through the bolt C: the other end of it is a male screw.

P, Q, are two collars fixed on the splinter-bar, which collars confine the axis, and prevent its being displaced.

Fig. 4, shows the pulley G, round which the chain D passes: the axis of this pulley contains two female screws, R, S, with threads in different directions moving the two bars, T, V, backwards or forwards, so as to protrude them on the conical part of the naves of the fore-wheels of the carriage, and to act as a brace thereon, so as to retard their motion.

Fig. 5, is a link of the chain, in order to show its make or formation.

When the horses are to be detached, and the carriage stopped, the coachman, sitting on the coach-box, draws up a handle W, Fig. 1, affixed to the chain D by means of an iron bolt with a spring upon it, to retain it when drawn out: the chain D pulls back the quadrant K, and draws back the double bolts N, N, which pass through square holes at the lower end of the rollers B. The same motion of the quadrant, by means of its female screw, raises the screw-bolt O, and sets the pole at liberty; so that the horses move off with the pole and rollers. It has been before observed, that the chain D winds once round the pulley G; by this means, when the chain is drawing up to detach the horses, the motion of the pulley propels, from its female screw on each side, bolts which have screw-heads at one end, and wedges at the other, which wedges, when propelled, act as braces on the conical-

formed

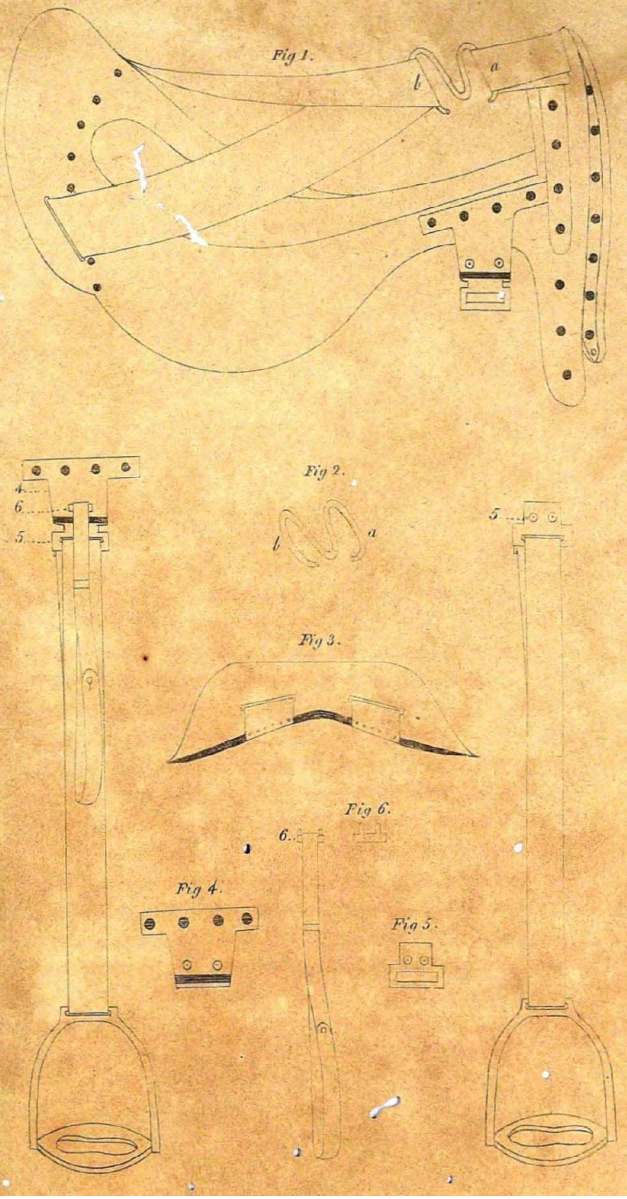


Fig 1.
a
b
Fig 2.
b
a
Fig 3.
4
6
5
5
Fig 6.
6
Fig 4.
Fig 5.

formed naves of the fore wheels, and ſtop the motion of the fore wheels.

X, is a ſquare head on the axis of the quadrant K: by means of a key applied on this head, when neceſſary to attach the horſes to the carriage, the quadrant is returned to its place, and bolts the rollers and pole, after they are replaced in their proper ſituations; the quadrant at the ſame time pulls back the chain on the pulley G, which pulley draws back the wedge-bolts from the conical naves of the fore wheels, and ſets them free to move.

The Committee of Mechanicks, to whoſe conſideration this buſineſs was referred by the Society, appointed a trial to be made near the Magazine in Hyde Park, on Thurſday, the 27th of March, 1800, with a coach, to which the apparatus was attached. Four horſes and two poſtillions were employed for the purpoſe. A perſon ſitting on the coach-box looſed the pole and rollers from the carriage, by pulling a chain placed near the boot, which chain drew back the bolts in the ſplinter-bar, and allowed the pole and rollers to be carried off by the horſes, at a time when they were gallopping at the rate of more than ten miles an hour. The experiment was repeated thrice, and the horſes diſengaged each time; but the impetus given to the carriage by the velocity of the horſes, occaſioning the coach to run forwards above twenty yards on level ground, after the horſes were detached, the Committee were of opinion, that a part, but not the whole of the object of the Society was anſwered, as the paſſengers in the carriage might yet ſuffer injury from the motion of the

 carriage

carriage after the horſes were liberated. On their noticing this circumſtance to Mr. Davis, and a gripe being added to ſtop the motion of the wheels, Mr. Davis, on the 8th of May laſt, produced the preſent ingenious invention to the Committee; by means of which, at one pull of the chain, the horſes may be liberated, and two bolts propelled on the nave of the two fore wheels, ſo as to retard their motion.

XXIX. *Account of a new Eudiometer.* *By Mr.* DAVY.

From the JOURNALS of the ROYAL INSTITUTION of GREAT BRITAIN.

THE dependance of the health and exiſtence of animals upon a peculiar ſtate of the atmoſphere, and the relations of this ſtate to proceſſes connected with the moſt eſſential wants of life, have given intereſt and importance to inquiries concerning the compoſition and properties of atmoſpheric air.

This elaſtic fluid has been long known to conſiſt chiefly of oxygen and nitrogen, mingled together, or in a ſtate of looſe combination, and holding in ſolution water.

A variety of proceſſes have been inſtituted with the view of determining the relative proportions of the two gaſes, but moſt of them have involved ſources of inaccuracy; and lately all, except two

two (the ſlow combuſtion of phoſphorus, and the action of liquid ſulphurets), have been generally abandoned.

Both phoſphorus and ſolution of ſulphuret of potaſh abſorb the whole of the oxygen of atmoſpheric air at common temperatures, and they do not materially alter the volume, or the properties of the reſidual nitrogen; but their operation is extremely ſlow; and in many caſes it is difficult to aſcertain the period at which the experiment is completed.

I have lately employed as an eudiometrical ſubſtance the ſolution of green muriate, or ſulphate, of iron, impregnated with nitrous gas; and I have found that it is in ſome reſpects ſuperior to many of the bodies heretofore uſed, as it rapidly condenſes oxygen without acting upon nitrogen; and requires for its application only a very ſimple and a very portable apparatus.

This fluid is made by tranſmitting nitrous gas through green muriate, or ſulphate, of iron, diſſolved to ſaturation in water *. As the gas is abſorbed, the ſolution becomes of a deep olive brown, and when the impregnation is completed it appears opaque, and almoſt black. The proceſs is apparently owing to a ſimple elective attraction; in no caſe is the gas decompoſed; and under the exhauſted receiver it aſſumes its elaſtic form, leaving the fluid with which it was combined unaltered in its properties.

The inſtruments neceſſary for aſcertaining the compoſition of the atmoſphere, by means of im-

* Dr. Prieſtley firſt obſerved this proceſs: for a particular account of it ſee Reſearches, Chemical and Philoſophical, p. 152, Johnſon.

pregnated ſolutions, conſiſt ſimply of a ſmall graduated tube, having its capacity divided into one hundred parts, and greateſt at the open end; and of a veſſel for containing the fluid.

The tube, after being filled with the air to be examined, is introduced into the ſolution; and, that the action may be more rapid, gently moved from a perpendicular towards a horizontal poſition. Under theſe circumſtances the air is rapidly diminiſhed; and, in conſequence of the dark colour of the fluid, it is eaſy to diſcover the quantity of abſorption. In a few minutes the experiment is completed, and the whole of the oxygen condenſed by the nitrous gas in the ſolution in the form of nitrous acid.

In all eudiometrical proceſſes with impregnated ſolutions, the period at which the diminution is at a ſtand muſt be accurately obſerved; for, ſhortly after this period, the volume of the reſidual gas begins to be a little increaſed, and after ſome hours it will often fill a ſpace greater by ſeveral of the hundred parts on the ſcale of the tube, than that which it occupied at the maximum of abſorption.

This circumſtance depends upon the ſlow decompoſition of the nitrous acid (formed during the experiment) by the green oxide of iron, and the conſequent production of a ſmall quantity of aëriform fluid (chiefly nitrous gas) *; which,

* The decompoſition of nitrous acid by ſolutions containing oxide of iron, at its minimum of oxidation, is a very complex proceſs. The green oxide, during its converſion into red oxide, not only decompoſes the acid, but likewiſe acts upon the water of the ſolution; and ammoniac is ſometimes formed, and ſmall portions of nitrous oxide and nitrogen evolved with the nitrous gas.

having

having no affinity for the red muriate, or ſulphate, of iron produced, is gradually evolved, and mingled with the reſidual nitrogen.

The impregnated ſolution with green muriate is more rapid in its operation than the ſolution with green ſulphate. In caſes when theſe ſalts cannot be obtained in a ſtate of abſolute purity, the common or mixed ſulphate of iron may be employed. One cubic inch of moderately ſtrong impregnated ſolution is capable of abſorbing five or ſix cubic inches of oxygen, in common proceſſes; but the ſame quantity muſt never be employed for more than one experiment.

A number of comparative experiments, made on the conſtitution of the atmoſphere at the Hot-wells, Briſtol, in July, Auguſt, and September, 1800, with phoſphorus, ſulphurets of alkalies, and impregnated ſolution, demonſtrated the accuracy of the proceſſes in which the laſt ſubſtance was properly employed. The diminutions given by the ſulphurets were indeed always greater by a minute quantity than thoſe produced by phoſphorus and impregnated ſolutions: but the reaſon of this will be obvious to thoſe who have ſtudied the ſubject of Eudiometry. In no inſtance was it found that 100 parts in volume of air contained more than 21 of oxygen; and the variations connected with different winds, and different ſtates of temperature, moiſture, &c. were too ſmall, and too often related to accidental circumſtances, to be accurately noticed.

In analyſing the atmoſphere in different places, by means of impregnated ſolutions, I have never been able to aſcertain any notable difference in the proportions of its conſtituent parts. Air, collected

lected on the sea, at the mouth of the Severn, on October the 3d, 1800, which must have passed over much of the Atlantic, as the wind was blowing strong from the west, was found to contain 21 *per cent.* of oxygen in volume; and this was nearly the proportion in air sent from the coast of Guinea, to Dr. Beddoes, by two surgeons of Liverpool.

If we compare these results with the results gained more than twenty years ago, by Mr. Cavendish, from experiments on the composition of atmospherical air, made at London and Kensington; considering, at the same time, the researches of Berthollet in Egypt and at Paris, and those of Marti in Spain, we shall find strong reasons for concluding, that the atmosphere, in all places exposed to the influence of the winds, contains very nearly the same proportions of oxygen and nitrogen: a circumstance of great importance; for, by teaching us that the different degrees of salubrity of air do not depend upon differences in the quantities of its principal constituent parts, it ought to induce us to institute researches concerning the different substances capable of being dissolved or suspended in air, which are noxious to the human constitution; particularly as an accurate knowledge of their nature and properties would probably enable us, in a great measure, to guard against, or destroy, their baneful effects.

XXX. *An Enquiry into the Causes of the Insalubrity of flat and marshy Situations; and Directions for preventing or correcting the Effects thereof.*

(Concluded from Page 124.)

IT was formerly discovered by Vesalius, and has since been confirmed by the observations of doctors Lower, Priestley, Crawford, and others, that the blood in the pulmonary veins is of as red and florid a colour as in the arteries, which is the reverse in every other part of the system. This circumstance has been demonstratively proved to be owing to the action of the oxygen, or the base of pure air upon the blood in the pulmonary veins.

From the experiments of the discerning and ingenious Dr. Goodwin upon living animals, it appears, that the action of the heart cannot be continued by the reception of the blood, which has not undergone this change of colour in the pulmonary veins from the application or introduction of oxygen. This fact has been since confirmed by the experiments of Dr. Girtanner, as may be seen in his essay on the principle and laws of irritability.

That blood impregnated with oxygen, or the base of pure air is the necessary and appropriate stimulus for giving motion to the heart, and enabling it to carry on the circulation of the blood, was rendered evident from the gradual diminution and debility of its contractions, as the colour of the blood became darker when the pure air was excluded, and from its contractions becoming

coming ſtronger as the blood recovered its florid colour from the application of pure air.

In theſe experiments, all the other functions of the body were obſerved to be proportionally affected with the heart. As its contractions diminiſhed, the power of theſe alſo declined: as the power of the heart recovered, theſe alſo recovered.

By theſe experiments we learn that the abſtraction or excluſion of the oxygenous part of the atmoſphere, in a given ſpace, is ſufficient of itſelf to deprive animals of life by withholding the cauſe of action. Hence we are authoriſed, by the chaſteſt rules of induction, to conclude, that health and life muſt be affected, more or leſs, in proportion to the quantity of this vivifying principle at any time abſtracted from the atmoſphere, which more immediately ſurrounds us.

The preſence of the other component part of the atmoſphere, the baſe of the azotic gas though totally oppoſite to the oxygen with which it forms a perfect compound, and neutral ſubſtance when mixed in the proportions already mentioned, appears to have no ſhare in deſtroying life, though its name is derived from a miſtaken ſuppoſition that it had the effect; for the heart immerſed in this gas will retain its irritability ſeveral hours, in a warm ſituation, after all ſigns of life have diſappeared in the reſt of the body. Mr. Valli's experiments on animal electricity have eſtabliſhed this fact.

Carbonic gas, or fixed air, on the contrary, produces its deſtructive effects by a direct operation, for it deſtroys the nervous power and the irritability of the muſcular fibres the inſtant that it

it is received into the lungs, and comes in contact with the heart.

If the carbonic gas operated, as suggested by Mr. Kite, by inducing a spasm of the glottis, and thereby excluding the atmospheric air, the heart, as in other cases of suspended respiration, would retain its irritability for some time; but this is not the case.

From the facts and observations which have now been stated, I think it may be fairly concluded, that the causes of the unwholesomeness of low and moist situations in the summer and autumnal months, is not owing to any invisible miasmata or noxious effluvia, which issue from the soil, and lurk in the air, but to a very different cause, *viz.* to a deficiency of the oxygenous portion of the atmosphere in such situations, in consequence of vegetable and animal putrefaction, in conjunction with the exhausting and debilitating heat of the days, and the sedative power of the cold and damp air of the nights.

For want of the refreshing and salutary stimulus of the pure air, all the functions of the body are performed imperfectly and languidly. The nervous system in particular becomes preternaturally susceptible of impressions from every change that occurs in the temperature of the surrounding atmosphere. The application of, or exposure to, a damper and colder state of the air than usual, renders the vessels on the surface of the body powerless and atonic, the brain and heart sympathise with the extreme nerves and vessels, the power of every function of the body declines, till the heart, roused by accumulating blood, reacts with increasing velocity, and is relieved of the unusual burthen.

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That the causes which I have now assigned are the true ones, is rendered next to certain, from the frequent occurrence of those diseases, (which have heretofore been supposed to depend upon the operation of specific miasmata,) in situations remote from marshy grounds, particularly in large and populous cities, where sedentary occupations, and want of exercise, render the inhabitants delicate and infirm. I have seen numerous instances of this kind even in the winter season, when no effluvia from marshes could possibly exist, especially among those who had been previously debilitated by other disorders. Nor is it uncommon for persons who have recovered from intermittents in the autumn, to have frequent recurrences of the same disease in the winter, merely from sitting in a damp room, or other exposure to cold.

In persons much reduced by the diseases of autumn, it is also very common, when attacked with the inflammatory diseases of winter, for the system to resume its customary habits of action, and for the fever to resemble an intermittent in the time and manner of its exacerbations and remissions, and immediately after the removal of the local affection to become a regular intermittent. This is so generally the case on the eastern shore of Maryland, that the physicians in that country seldom make much use of the lancet in any of the diseases which occur there, except in the spring season. Are we not authorised, from these facts, to infer, that any circumstances which occasion a certain state of debility and irritability in the vessels and nerves on the surface of the body, and in the sensorium at the same time, are predisposing causes of the diseases we are now con-

sidering

sidering, and that when the system is in this condition by whatever cause induced, the sudden application of cold, terror, or any other suddenly debilitating power, may become the exciting or occasional cause of febrile disease, in an indirect manner by repelling the blood to the heart, lungs, and brain, and forcing them to react by the stimulous of distension?

If the diseases of marshy situations were produced by a specific matter, they could never be produced by any other cause; but as they are frequently induced in seasons and situations, where that supposed specific matter or miasma cannot possibly exist, there is nothing more clear than that they are not produced by any such specific matter.

The opinion, that those diseases are the product of specific matter generated by vegetable putrefaction,, appears to be rendered groundless from the disease varying in its type and symptoms, in proportion to the extent and putridity of the soil, state of climate, season and weather, with respect to heat, moisture, &c. and also in its not being contagious, the reverse of which is the case with all known diseases that are derived from specific matter.

We are assured, by the accurate Monro, in his account of the diseases which prevailed in the military hospitals in Germany, in 1761 and 1762, that the intermitting fever seldom attacked any but those whose solids had been previously relaxed by the preceding heat of the summer, except when they had been fatigued and over-heated by the sun, and afterwards exposed to the evening dews.

Dr. Lind, of Windsor, says, sudden exposure to cold occasioned either an inflammatory fever or a simple intermittent at Bengal, according to the predisposition of the body.

The scurvy, as well as the diseases already enumerated, also appears to derive its existence from a deficiency of pure air in conjunction with a cold and moist atmosphere, and a diet of salted flesh meats. For it generally prevails in long voyages after a continuance of wet weather. The hatches being kept shut at such times, prevents ventilation, in consequence of which the oxygen becomes exhausted.

Captain Cook in his two last voyages preserved his crew from the scurvy by frequent ventilation, constant cleanliness, suitable cloathing, and strict discipline.

Dr. Trotter assures us, that in a slave ship, of which he was surgeon, the seamen that were constantly on deck, and fed with the ordinary sea diet, remained free from the scurvy, while the slaves, that lived principally on vegetables, but breathed a confined impure air, fell miserable victims to it.

The remarkable case of the blue boy, described by Dr. Sandifort, of Leyden, furnishes another striking example of the importance of oxygen in the preservation of health and life, as well as a confirmation of its being the cause of the red colour of the blood.

In this boy, whose skin was as blue as indigo, the aorta communicated with both ventricles of the heart, in consequence of which the greatest part of the blood was immediately propelled from the right ventricle into the aorta, so that very little

little passed into the pulmonary artery to be oxygenated.

An opinion equally erroneous with that which has lately prevailed respecting the causes of intermittent fevers, &c. has also been delivered down from age to age, respecting the causes of continued fevers of the nervous or putrid kind.

The doctrine formerly taught respecting these was, that they derived their existence from the effluvia of dead and putrid animal substances: but, from more recent and accurate observations, it appears that the contagion by which this kind of fever is produced, as well as those of a pestilential nature, is always derived from the living human body in confined and unventilated situations, and it is probable that the effluvia thus excreted, partake of the quality of nitrogen gas, from their being rendered harmless by a union with oxygen or the base of pure air.

It appears more than probable also, from the history of the circumstances always present at the time febrile contagion is generated, that it is rendered virulent and powerful in proportion to the absence or defect of oxygen, and the degree of heat to which the living body has been exposed in such situations. It was a concurrence of these circumstances which gave origin to the yellow fever which appeared in Grenada in the beginning of the year 1793, and which was afterwards imported into Philadelphia, as appears from the account published by Dr. Chisholm *.

Noxious effluvia indeed frequently arise from putrid animal substances in confined situations.

* Vide Chisholm's Essay on the fever of Grenada in 1793, &c.

Dr,

Dr. Monro mentions a remarkable inſtance of this, and ſome later examples are recorded by Mr. St. John; but it does not appear from theſe caſes, that thoſe noxious effluvia produced any ſymptoms reſembling thoſe of putrid or peſtilential fevers: on the contrary, they acted as direct ſtimulants, and occaſioned inflammatory affections without being preceded by that ſenſe of debility which always precedes thoſe fevers that are occaſioned by febrile contagion.

Having now ſhown that the diſeaſes which prevail moſt generally during the autumnal ſeaſon in low and marſhy ſituations, owe their origin not to inviſible exhalations or miaſmata, but to the cauſes which I have aſſigned; the prophylaxis, or the means of preventing the occurrence of thoſe diſeaſes, muſt be ſimple and obvious.

Theſe are to introduce and increaſe the proportion of oxygenous gas in the ſuperincumbent atmoſphere, and to prevent its future abſtraction, by cutting off or diminiſhing the ſources of putrefaction.

It would be a happy circumſtance, if the application of the means ſuited, to produce an amendment in a body ſo large and fluctuating as the atmoſphere, was as practicable as the means ſuited to effect that purpoſe are obvious: but, unfortunately, this requires too much labour and expenſe to admit of extenſive applications eſpecially in a country where population, and wealth do not bear a due proportion to the extent of territory.

We ought, however, to attempt every thing in our power to effect ſo deſirable and uſeful an event.

Chemiſtry

Chemistry furnishes various articles by means of which we can generate and introduce a supply of oxygen into the atmosphere, as well as alter the quality of those noxious gases with which it is occasionally contaminated.

These, however, can only be employed in a very limited and partial manner, and of course can only produce a limited and partial amendment.

I shall therefore mention only a few of the substances that may be occasionally employed for this purpose.

A large portion of oxygen may be furnished by the decomposition of nitre, as is demonstrated from its maintaining the combustion of inflammable bodies.

If lighted charcoal be placed in a proper exposure to the open air, it will continue to burn till the whole be reduced to ashes.

If nitre be mixed with charcoal, and when kindled placed in a close vessel, the combustion will continue as well as if exposed to the open air; whereas, without the assistance of the nitre, the charcoal would be immediately extinguished in that situation for want of a supply of oxygen.

Mr. Schele, by heating nitre to red heat in a retort, received into a moistened bladder more than fifty ounces in measure of oxygen gas from one ounce of nitre. A pound will therefore furnish 800 ounces.

Nitre ground with two-thirds of its weight of mintum and moistened with water, so as to form a paste, burns very rapidly, and emits a considerable quantity of pure air.

But the grand engine, by which the sources that deprive the atmosphere of its salutary and vivifying principle are to be cut off, and the great magazine,

magazine, from whence a sufficient supply is to be obtained, must be sought for in the art of agriculture.

The stagnant waters may be carried off, and the soil of marshes rendered dry, by means of drains, deep trenches, and wells; and farther stagnation and putrefaction prevented, by consuming the dead weeds, grass, and woods, and by filling up the flats, sinks, and hollows, with clay, sand, or lime.

And the atmosphere may be supplied with a profusion of oxygen by cultivating on such soils grasses and plants of vigorous growth, and especially those which live and flourish latest in the season. For vegetables, while living and growing, when exposed to the rays of light, constantly decompose the water they imbibe from the earth and air, and while they retain the hydrogen or base of inflammable air for the formation of oil, wax, honey, or resin, they replenish the atmosphere with oxygen *.

When it is impracticable to render marshy situations dry, on account of their extent, they should be kept constantly flooded by means of dams and sluices, to prevent the effects of putrefaction; for, when dead vegetable or animal substances are immersed in water so as to be entirely excluded from contact with the air, putrefaction can only take place in a slow and imperfect manner.

But clearing the woods, plants, and herbs, from marshy or fenny tracts, without draining off the stagnant water at the same time, and destroying the dead herbage by fire, instead of rendering such situations more healthful, has been

* Chaptal's Chemistry. Ingenhausz's Observations, &c.

found

found to have a different effect, becaufe a greater extent of putrefcent furface is thereby expofed to the rays of the fun, and of courfe a greater portion of oxygen abftracted from the atmofphere. It is owing, in a great meafure, to this circumftance, that all new countries are fo generally fatal to the firft fettlers.

The fame land after it has been cultivated a few years, efpecially if there be fufficient declivity to prevent the water from ftagnating, lofes its unwholefomenefs, the putrefcent fubftances mixed with the foil or fuperficial ftratum of the ground having finifhed the putrefactive procefs by that time. In order, therefore, to render and preferve marfhy countries healthful, they fhould be preferved dry and clean by means of the fpade, the plough, and the rake.

When the level fituation of a place prevents the ftagnant water from being carried off by drains, deep wells fhould be dug, in different places, for the water to collect in, by which means a greater portion of the foil will be rendered dry, and lefs noxious.

To prevent ftill farther the injurious effects of refiding near marfhes or mill-ponds, rows of fuch trees as grow rapidly, and retain their verdure late in the feafon, fhould be planted between thofe fituations and the manfion, for the purpofe of intercepting the moifture in its progrefs, while they furnifh a conftant fupply of oxygen to the atmofpere.

Lodging in the upper ftory of a houfe has been found to preferve health during a fickly feafon, inftances of which are recorded by Sir John Pringle. This appears to be owing to thofe fituations being out of the reach of the moifture from the ground.

XXXI. *On the Use of Steam as a Vehicle for conveying Heat from one Place to another. By Count* RUMFORD.

From the JOURNALS of the ROYAL INSTITUTION of GREAT BRITAIN.

MORE than fifty years ago, Colonel William Cook, in a paper prefented by him to the Royal Society, and publifhed in their Tranfactions, made a propofal for warming rooms by means of metallic tubes filled with fteam, and communicating with a boiler fituated out of the room; which propofal was accompanied by an engraving, which fhowed, in a manner perfectly clear and diftinct, how this might be effected. Since that time this fcheme has frequently been put in practice with fuccefs, both in this country and on the continent *. — Many attempts have likewife been made, at different periods, to heat liquids by means of fteam introduced into them; but moft of thefe have failed: and, indeed, until it was known that fluids are nonconductors of heat, and, confequently, that heat cannot be made to *defcend* in them, (which is a recent difcovery,) thefe attempts could hardly fucceed; for, in order to their being fuccefsful, it is abfolutely neceffary that the tube which conveys the hot fteam

* Although one fhould naturally imagine that the notoriety of thefe facts would have been fufficient to prevent all attempts in our days to claim a right to this invention, yet it is faid that a patent for it was taken out only a few years ago. See Mr. Green's fpecification, publifhed in our firft volume, page 21.

fhould

should open into the *lowest part* of the vessel which contains the liquid to be heated, or on a level with its bottom;—but as long as the erroneous opinion obtained, that heat could pass in fluids *in all directions*, there did not appear to be any reason for placing the opening of the steam-tube *at the bottom of the vessel*, while many were at hand which pointed out other places as being more convenient for it.

But to succeed in heating liquids by steam, it is necessary, not only that the steam should enter the liquid at the bottom of the vessel which contains it, but also that it should enter it *coming from above*. The steam-tube should be in a vertical position, and the steam should *descend* through it previous to its entering the vessel, and mixing with the liquid which it is to heat; otherwise this liquid will be in danger of being forced back by this opening into the steam-boiler; for the hot steam being suddenly condensed on coming into contact with the cold liquid, a vacuum will necessarily be formed in the end of the tube; into which vacuum the liquid in the vessel—pressed by the whole weight of the incumbent atmosphere—will rush with great force, and with a loud noise; but if this tube be placed in a vertical position, and if it be made to rise to the height of six or seven feet, the liquid which is thus forced into its lower end will not have time to rise to that height before it will be met by steam, and obliged to return back into the vessel.—There will be no difficulty in arranging the apparatus in such a manner as effectually to prevent the liquid to be heated from being forced backwards into the steam-boiler; and, when this is done, and some other

neceſſary precautions to prevent accidents are taken, ſteam may be employed with great advantage for heating liquids; and for keeping them hot, in a variety of caſes, in which fire, applied immediately to the bottoms of the containing veſſels, is now uſed.

In dying, for inſtance, and in brewing; and in the proceſſes of many other arts and manufactures, the adoption of this method of applying heat would be attended not only with a great ſaving of labour and of fuel, but alſo of a conſiderable ſaving of expence in the purchaſe and repairs of boilers, and of other expenſive machinery: for when ſteam is uſed inſtead of fire for heating their contents, boilers may be made extremely thin and light; and, as they may eaſily be ſupported and ſtrengthened by hoops and braces of iron, and other cheap materials, they will coſt but little, and ſeldom ſtand in need of repairs. To theſe advantages we may add others of ſtill greater importance: boilers intended to be heated in this manner may, without the ſmalleſt difficulty, be placed in any part of a room, at any diſtance from the fire, and in ſituations in which they may be approached freely on every ſide. They may moreover eaſily be ſo ſurrounded with wood, or with other cheap ſubſtances, which form warm covering, as moſt completely to confine the heat within them, and prevent its eſcape. The tubes by which the ſteam is brought from the principal boiler (which tubes may conveniently be ſuſpended juſt below the cieling of the room) may, in like manner, be covered, ſo as almoſt entirely to prevent all loſs of heat by the ſurfaces of them; and this to whatever diſtances they may be made to extend.

In ſuſpending theſe ſteam-tubes, care muſt, however, be taken to lay them in a ſituation *not perfectly horizontal* under the cieling, but to incline them at a ſmall angle, making them riſe gradually from their junction with the top of a large vertical ſteam-tube, connecting them with the ſteam-boiler, quite to their fartheſt extremities: for, when theſe tubes are ſo placed, it is evident that all the water formed in them, in conſequence of the condenſation of the ſteam in its paſſage through them, will run backwards, and fall into the boiler, inſtead of accumulating in them, and obſtructing the paſſage of the ſteam, which it would not fail to do were there any conſiderable bends or wavings, upwards and downwards, in theſe tubes, or of running forward, and deſcending with the ſteam into the veſſels containing the liquids to be heated, which would happen if theſe tubes inclined *downwards* inſtead of inclining upwards, as they recede from the boiler.

In order that clear and diſtinct ideas may be formed of the various parts of this apparatus, even without figures, I ſhall diſtinguiſh each part by a ſpecific name: the veſſel in which water is boiled in order to generate ſteam, and which, in its conſtruction, may be made to reſemble the boiler of a ſteam-engine, I ſhall call the *ſteam-boiler*: the vertical tube, which, riſing up from the top of the boiler, conveys the ſteam into the tubes, (nearly horizontal,) which are ſuſpended from the ceiling of the room, I ſhall call the *prime conductor*: to the horizontal tubes I ſhall give the name of *horizontal conductors*, or ſimply *conductors of ſteam*: and to the (ſmaller) tubes, which, deſcending perpendicularly from theſe *horizontal*

horizontal conductors, convey the ſteam to the liquids which are to be heated, I ſhall, excluſively, appropriate the appellation of *ſteam-tubes*.

The veſſels in which the liquids are put that are to be heated I ſhall call the *containing veſſels*. —Theſe veſſels may be made of any form; and, in many caſes, they may, without any inconvenience, be conſtructed of wood, or of other cheap materials, inſtead of being made of coſtly metals, by which means a very heavy expence may be avoided.

TO BE CONCLUDED IN OUR NEXT.

XXXII. *Concerning the Oil extracted from the* Cornus Sanguinea. (*Linn.*)

By Citizen MARQUERON, *of Straſburg*.

FROM THE *ANNALES DE CHIMIE*.

THE *cornus ſanguinea* of Linnæus, a ſhrub ſo much eſteemed by ornamental gardeners, for embelliſhing clumps of trees, both on account of its beautiful form, and the fine red colour which its branches and leaves aſſume towards the cloſe of the ſummer, bears a berry, which, when ripe, is of a blackiſh colour, whoſe utility, both for the purpoſes of medicine and the arts, has never hitherto been properly eſtimated.

The greaſy unctuous appearance which theſe berries exhibit when cruſhed between the fingers, led

led me to imagine that they might contain an oil, which certainly muſt poſſeſs ſome uſeful properties. Well perſuaded of this truth, that none of Nature's productions are without their uſe, I prevailed upon Citizen Chevreuſe, botanical gardener at Molſheim, in the department of the Lower Rhine, where this ſhrub grows in great abundance, to collect a quantity of its berries.

Ten kilogrammes of theſe berries were collected and ſpread out in a garret, not for the purpoſe of drying them, but in order that they might acquire a ſofter conſiſtence: in this ſtate they were reduced to a paſte, and ſubjected to the preſs, where, without the application of heat, two litres were obtained, of a greaſy unctuous liquid, poſſeſſing a degree of viſcidity ſimilar to that of oil, of a green, though very pellucid, colour; it was perfectly homogeneous, and exhibited all the phyſical properties of a real oil, without poſſeſſing either a diſagreeable ſmell or taſte, which determined Citizen Chevreuſe and me to eat a ſallad prepared with it, which we did ſeveral times without experiencing any bad effects from it. Theſe properties, however, not being ſufficient to demonſtrate that this liquid was really an oil, I undertook the taſk of ſubjecting it to various experiments, of which the reſult is as follows.

A drop of this oily liquid, when let fall into a veſſel filled with water, extended itſelf over its ſurface in a very fine pellicle, which reflected the priſmatic colours.

Wiſhing to know whether it were poſſible to deprive this oily ſubſtance of its green colour, I waſhed it with cold and hot water, the water being charged with ſulphate of alumine, powdered ſlate, charcoal-powder, &c. All theſe different means

means were of no effect, the liquids above mentioned did not receive any new tinge, and the green colour of the oil remained always the ſame.

Alcohol was alſo employed. This menſtruum having aſſumed a greeniſh tinge, I imagined that I ſhould be able thereby to extract the colouring matter of the oily liquid; for which purpoſe I added a portion of this alcohol, tinged as above mentioned, to a certain quantity of water. The mixture immediately became white, and ſome drops of oil ſwam at the top. I evaporated, in a diſtilling apparatus, another portion of this coloured alcohol: the alcohol which I thus obtained was colourleſs, and there remained behind a quantity of oil, of the ſame colour as before: the alcohol therefore owed its colour only to the ſolution of a portion of the oil, and not to the ſeparation of the colouring principle.

Sulphur combined completely with this oil: with the aid of caloric, there reſulted from this combination a real balſam of ſulphur, of a fine deep red colour, verging upon the brown, and of an extremly fetid ſmell.

Potaſh, ſoda, and ammonia, formed with this oil real ſoaps, poſſeſſing different degrees of ſolidity.

The concentrated ſulphuric acid, combined with this oil, produced a real acid ſoap, of a yellowiſh colour, and the appearance of a reſin.

The nitric and muriatic acids exhibited no perceptible operation upon the oil, when applied to it in the cold way, excepting that they aſſumed a ſlight greeniſh tinge.

Nitric acid, when heated with this oil, cauſed it to aſſume a ſolid conſiſtence, and a yellow colour,

colour, perfectly refembling that of yellow pomatum; during the ebullition there took place a confiderable fwelling in the mafs, an extrication of nitrous gas, &c. The theory of this operation being perfectly well known, it will be unneceffary to explain it in this place.

Not having been able to procure nitrous acid, it was impracticable for me to afcertain the inflammability of this oil by the acids.

By boiling for fome time upon litharge, this oil acquired the ficcative property, which rendered it fit for being employed in painting, a property which it poffeffed before its oxygenation, but in a lefs degree than afterwards.

By continuing the ebullition, the oxyde of lead was difoxydated, and entirely diffolved; and the mixture acquired a confiftence and brown colour, perfectly refembling that of the brown ointment *(onguent de la mere.)*

I repeated the fame experiment, taking care to add water, and conftantly ftir the liquid, in the manner which is practifed in preparing the *diapalma* plafter; by which means I obtained a fubftance of a good confiftence, and a colour perfectly refembling that of the *Empl. de vigo cum mercurio:* this colour having made me believe that I had failed to obtain a plafter, which I imagined ought to be of a whitifh colour, I repeated the experiment feveral times with all poffible attention; and every time I obtained a plafter of the fame colour. The theory of plafters having been very well explained by Citizen Deyeux, it may be difpenfed with in this place. I expofed a quantity of this oil to the contact of the atmofpherical air: after fome time it was found to have acquired a fomewhat greater degree of confiftence.

The same experiment was repeated, but with the addition of water, and the observance of all the precautions directed by Citizen Berthollet: at the end of a month the oil had acquired a solid consistence, and a white colour, similar to that of wax.

Wishing, finally, to know of what utility this oil might be for domestic purposes, I poured it into a lamp with cotton wicks, which being lighted threw out a bright light, without any perceptible smoke or smell: the same lamp, with wicks of the same kind, was successively filled with oil of olives and rape-seed oil; the latter burnt two hours, the olive oil two hours and a quarter, and the oil of the *cornus sanguinea* two hours and a half.

If we add to these facts, the property of congealing, which belongs to this oil, we shall have all the characters of the oil of the *cornus sanguinea*.

From these experiments, which are all that I have had it in my power to make, I am authorized to conclude, that the oily juice obtained by expression from the *cornus sanguinea* is a real oil, possessing certain properties that may render it useful in the arts, commerce, and perhaps in medicine. I also think that it ought to be placed, according to Fourcroy's principles, in the second class, which comprehends the siccative oils, which speedily grow thick, are not congealed by the action of the cold, take fire with nitrous acid alone, and form with sulphuric acid resinous compositions.

XXXIII. *Obſervations concerning the Aſhes of different Kinds of Wood.* By C. PISSIS, *M. D.*

FROM THE *ANNALES DE CHIMIE*.

HAVING burnt a conſiderable quantity of poplar-wood, during the winter of the year 8, I obſerved that the aſhes, when heated again, formed ſemi vitreous cruſts, ſuch as that produced from the aſhes of the ſea-weed, excepting that they were very thin and ſmall, having been neither agitated, nor expoſed to any other heat than that of a moderate chamber fire.

At firſt I ſuppoſed the cauſe to be an extraordinary quantity of potaſh, but as I could not attribute it to the quality of the wood, white woods having always been reckoned to yield a ſmaller quantity of ſalt than the others, (for example, the aſpin (*populus tremula*, Linn.) a tree of the ſame genus as our poplar, (*populus alba,*) yields only 9 gros. 45 grs. of potaſh to the quintal of the wood,) I imagined that the circumſtance depended upon a change in the ligneous ſubſtance. We cultivate poplar for the purpoſe of procuring props for our vines; and as it is bad fuel, we do not cut it down till it has ceaſed to produce any more ſhoots. It is not rare to ſee poplars, the bark and branches of which appear ſtill to poſſeſs a great deal of life, whilſt the trunk is reduced to a few handfuls of mould.

This idea of the augmentation of the potaſh in rotten wood was not ſtrictly juſt; but it ſhall be ſhewn that it has led me to ſome concluſions

 very

very different from the ideas generally received. I shall revert to all the points of theory, after having related the following facts, which tend to throw a light upon them.

1. One hundred parts of dry sound poplar wood yielded four parts of ashes.

2. One hundred parts of dry poplar wood, that was rotten, but not reduced to mould, yielded eight parts of ashes.

3. One hundred parts of each of these kinds of ashes, lixiviated till the water was drawn off insipid, and perfectly dried in a red heat, lost twenty-eight parts of their weight; the first waters having been very strongly impregnated.

4. One hundred parts of the same ashes, heated over again, and treated in the same manner as above, lost twenty-two parts; the leys were more strong and caustic than the preceding.

5. One hundred parts of the ashes of dry and sound oak, when heated over again, and treated as above, lost sixteen parts.

6. One hundred parts of the wet mould of rotten oak, of the colour of ochre, when placed upon a red hot plate of iron, were very soon dried and incinerated, leaving three parts of ashes, which, even when heated over again, had the colour of iron filings. This is nearly twice as much as the quintal of dry oak has generally yielded. These ashes were perfectly insipid.

7. One hundred parts of the crusts, of which I have spoken at the beginning of this memoir, when treated in the same manner as the ashes N° 3, lost thirty-seven parts of their weight. This crust at first seems insipid, the potash being as it were in a latent state; but after it has been

been kept for ſome time, and triturated, water extracts from it a large quantity of this ſalt; it is however probable, that ſome of it ſtill remains in the reſiduum. Theſe leys are extremely cauſtic.

8. Some pieces of this cruſt having been made red-hot, and afterwards extinguiſhed in a ſmall quantity of water, yielded a ley ſufficiently cauſtic to form ſoap with melted wax and tallow, upon which I poured the cold ley.

9. This ley, when filtrated through plaſter, (calcareous ſulphate mixed with lime,) burnt into powder, loſt its alkaline taſte, and yielded, by ſpontaneous evaporation, fine cryſtals of ſulphate of potaſh.

From theſe facts it appears:

1. From the four firſt compared with the fifth, that the wood of the white poplar abounds more in ſalt than that of the oak; ſo that this is an exception from the maxim generally adopted, that the hard woods contain a greater abundance of potaſh than the ſoft.

The wood of the poplar is of ſo ſpongy a texture, that rats cannot gnaw it through, as its fibres reſiſt the impreſſion of their teeth in the ſame manner as thoſe of hemp; it is alſo difficult to ſaw; this quality renders it expenſive for articles of furniture, and the more ſo, as this wood, which is very ſubject to rot, ought, in order to be fit for ſawing, to be cut down whilſt in its full vigour, againſt which there is a great objection, as has been already mentioned.

This wood burns, when it is dry, with a white flame, emits very little heat, is quickly conſumed, and yields no live coal. It is evident that the incombuſtible

combuſtible particles abound more in it than in the other kinds of wood; as is alſo the caſe with the willow, which yields twice as much aſhes, but only about the ſame quantity of ſalt as the oak; that is to ſay, 15 grammes for 1 myriagramme of the wood, whilſt our poplar yields 72. To what then are we to aſcribe this large quantity? this might be determined by analyſing its ſap: poſſibly alſo the acrid and viſcous fluid of its buds, which is uſed in pharmacy, might furniſh ſome data towards ſolving the queſtion.

According to a calculation made from the returns of the revenue collectors, a myriagramme of aſpen wood yields only 7 grammes of ſalt. (Ann. de Chimie, t. xix. p. 178 *.)

This difference in the quantity of ſalt, which is in the proportion of more than ten to one, in two trees of the ſame genus, will not ſurpriſe thoſe who know that the dock and ſorrel are of the ſame genus, and that the ſour and the bitter cherry are of one and the ſame ſpecies. Nature is not ſubject to our confined ideas of analogy. It has been laid down as a principle, that plants of the ſame family may mutually ſupply the place of each other for medicinal purpoſes; but prudence requires that we ſhould not act upon this principle, till after having accurately analyzed the

* I have not extracted the ſalt from the poplar wood, as the expanſion of it by lixiviation appeared to me to be the pureſt method of eſtimating it, for it is difficult to reduce the ſalt always to the ſame point of calcination. But having calculated that the aſhes of the oak loſe in lixiviation $\frac{16}{100}$, and yield in ſalt $\frac{13}{100}$, I have ſubtracted $\frac{3}{16}$ or $\frac{19}{100}$ for the loſs in lixiviation, and thus I conceive that I have the product in ſalt pretty near to the truth: this difference proceeds from the carbonic acid which the ſalt loſes during the proceſs of calcination.

two

two plants which we intend to ſubſtitute the one for the other.

2. From the five firſt experiments it appears, that rotten wood yields a larger quantity of aſhes than ſound, frequently more than twice as much. This circumſtance is eaſily accounted for. The wood, whilſt it rots, becomes ſpongy and light: I have ſeen ſome rotten wood which did not weigh more than half as much as an equal bulk of the ſound wood of the ſame tree. It burns without flame, like tinder, and it cannot be incinerated but with great difficulty. It appears that the hydrogen has been almoſt entirely deſtroyed; and that the carbon, by being ſheathed in the earthy particles, eſcapes the effects of combuſtion.

This wood has frequently a phoſphoreſcent quality, the cauſe of which ſtill remains to be diſcovered. We ought not to confound rotten wood with wood that has been eaten by worms. In the latter caſe, the wood, without loſing its colour, is reduced to an impalpable powder, and in that portion of the wood which ſtill retains its ſolidity we may find the paſſage which the worm has formed for itſelf, and frequently the worm itſelf. One hundred parts of vine-ſtalks, reduced to an impalpable powder by the worms, and burnt in a red heat, were perfectly incinerated, leaving three parts of aſhes, which is nearly the quantity obtained from a quintal of dry vine twigs burnt under the inſpection of the revenue officers. This wood, to which the term of *worm-eaten* peculiarly belongs, has nothing in common with the rotten wood, which is alſo termed worm-eaten, excepting its appellation, which is very improperly applied to the latter.

It

It has been asserted that rotten wood yields little salt *; and this assertion is true as far as applied only to wood washed out by the rain, and it is proved by Experiment 8; but Experiment 3 proves that wood which has rotted without being washed out in this manner, has not lost one particle of its potash; and that, as an equal weight of rotten wood yields twice as much ashes of equal quality, it will furnish double the quantity of salt: hence manufactories may derive great advantage, considering the small value which this wood generally bears.

One might employ, both in the preparation of leys for domestic purposes, and in the manufactories of nitre and salt, the ashes of dead trees, whose summits and bark being still in good preservation have prevented the access of the rain-water to the trunk. The mould of these trees might also be used as an excellent manure, since it retains the whole of its potash. It is further evident, that when this mould is washed by the rain it must be of advantage to the vegetation. The experiments of citizen Vauquelin have shewn us, that in the sap of trees the potash exists in the state of an acetite: it would be interesting to know also in what state it exists as well in the wood as in the mould of trees.

3. Experiment 4 shews that by baking the ashes over again they lose one-fifth of their salt:

* Annales de Chimie, t. xix. p. 160. The same is also asserted of the chips and shavings of the joiners shops; but this depends upon the quality of the wood that has been used, as the manner in which it has been divided produces no change in its properties.

this

this is a neceſſary conſequence of their loſing more and more of their carbonic acid; but at the ſame time they gain in quality, as is proved by Experiment 8. However, if we bake over again aſhes of a very rich quality, like thoſe of our poplar, we ſhall obtain a half vitrified cruſt which will retain a part of the potaſh; it will further be neceſſary to triturate this cruſt, in order to lixiviate it, which will add to the labour of the workmen. This cruſt, from which ſalt may be extracted in the proportion of 30 *per cent.* and which contains ſtill a good deal more in a concealed ſtate, might perhaps be employed in the manufacture of glaſs equally well with many kinds of ſoda. This ſemi-vitreous ſtate of the ſubſtance, and the ſolidity of the ſoaps obtained in Experiment 8, led me at firſt to ſuſpect that the aſhes of the poplar contained ſoda; but I was undeceived by Experiment 9. I made uſe of ſome parget, which I had by me, for want of ſulphuric acid, which was not immediately at hand. Franklin ſays, it is good to know how to ſaw with a wimble. For the ſame reaſon I made uſe of wax and tallow.

I ſhall conclude with ſome ideas to which this experiment gave riſe. Melted wax, tallow, and hogs-lard, and heated oils, acquire a temperature higher than that of water, and even of boiling ley: when an alkaline ley is added, the mixture immediately puffs up in an extraordinary manner, the whole of the water is inſtantly evaporated; and when the ingredients are employed in equal proportions, the ſoap remains more ſolid than that made according to the proceſſes uſually employed in the manufactories; beſides which, it is

dry as ſoon as formed. Theſe advantages are well worth the trouble of making ſome experiments, by which we might examine the following queſtions.

1. If the oil were heated before the water, would not the expanſion, which takes place when they are mixed together, occaſion ſome accident? —To me it appears that it would not, provided the boiler were ſufficiently large, and only one-fourth of its capacity filled.

2. Might the mixture be ſtirred? It might, after the whole of the ley has been added, as the mixture then remains in a tranquil ſtate of fuſion.

3. Would the ſalts which are of no uſe in forming the ſoap, particularly the alkaline carbonates, be carried off by the tube? I apprehend they would not; for, in the experiments which I have made on a ſmall ſcale, no liquid was left behind.

4. Would not the oily ſubſtances, by being too much heated, have their properties ſo altered as to affect the quality of the ſoap? I fear they would; for the ſoaps which I obtained were of a greyiſh colour,

XXXIV. *Observations on Opium, and its component Principles; with an Account of various Processes for obtaining it from the White Poppy* (Papaver Somniferum. *Linn.*)

By Citizen Dubuc, *Senior.*

FROM THE *ANNALES DE CHIMIE.*

THE natural history of opium does not appear to be hitherto generally well understood. It is doubted whether there exists any drop-opium, *(de l'opium en larmes)*; all that seems to be fully established as a fact is, that this singular substance is extracted by the inhabitants of the east from the white somniferous poppy; but the following questions respecting it still remain to be resolved. What are the processes used for obtaining it? What degree of maturity must this plant have arrived at, in order to produce opium such as that of commerce? Finally, Is this vegetable subjected to any particular kind of preparation, before the opium is extracted?

None of these questions have been satisfactorily determined by any of the writers who have treated of this subject.

Several natural historians, and especially Lemery, in his Dictionary of simple drugs, asserts positively that *there exists no drop-opium*, and that the opium of the Levant is obtained from the leaves and heads of the poppy. The most celebrated chemists who have treated of the subject, such as Fourcroy, Chaptal, Beaumé, Bouillon-Lagrange, &c. are not agreed amongst themselves, whether it is extracted from the leaves, stalks, and cap-

ſules, whilſt ſtill freſh and green, or whether it is obtained directly from the heads of the poppy when arrived at its laſt ſtage of growth and maturity, by making the extract in the ordinary manner.

This difference of opinion, which exiſts amongſt authors whoſe knowledge in natural ſcience cannot be called in queſtion, determined me, two years ago, to occupy myſelf with the inveſtigation of the nature of this ſubſtance, by cultivating, with this view, a great number of white poppies. *(Papaver album & ſomniferum. Linn.)*

But before I give an account of the various experiments which I have made in order to obtain opium, it will be proper that we ſhould eſtabliſh our opinion concerning two facts relative to this ſubſtance, ſuch as it is brought to us from the Levant in the ordinary courſe of commerce.

It is certain that the oriental opium contains impurities amounting at leaſt to one-fourth of its weight. I have frequently examined theſe heterogeneous ſubſtances, and, after different waſhings, I have eaſily diſcovered, that they were nothing elſe than the ſtalks, leaves, feculæ, peduncules, capſules, and ſeeds of the poppy, in a ſtate of very minute diviſion.

I ſhall ſhew hereafter that the addition of theſe ſubſtances contributes in a very great degree to give the opium that acrid and nauſeous ſmell which it is known to poſſeſs.

It is alſo known, that this acrid odour is extremely volatile, and that frequently it is not found to exiſt any longer at the ſurface of the cakes of opium, whether in conſequence of the length of time that they have been kept, or owing to ſome artificial means that have been employed

ployed for that purpose; whilst the lower part of the same cake, which is still viscous, is thoroughly imbued with it, and emits an intolerable smell when cut through the middle: hence it appears, that this volatile principle, or *aroma*, is only an accidental property of the opium.

The following experiments will elucidate what I have advanced, both with respect to the two last-mentioned facts, and the solution of the questions which I have proposed at the commencement of this memoir.

Experiment 1. If we dry viscous opium, in a temperature not exceeding 40—50 degrees of Reaumur's thermometer, till it becomes pulverulent, it will lose its acrid narcotic smell, and assume that of laudanum, or the purified opium of the shops, from which it differs only in the impurities which it contains. The vapours which arise from it, when collected in a convenient apparatus, become there in part condensed into a liquid, which at first is almost colourless, but in the space of a few days assumes a slight yellowish tinge. This *aroma*, or distilled spirit, is accompanied by an aëriform fluid, which is not altogether miscible with water, and both diffuse an odour resembling that of opium cakes when cut in half, but so extremely strong as very speedily to suffocate animals exposed to an atmosphere of this gas.

Last year I made the extract of white poppies, gathered at different periods of their growth, without ever having been able to obtain a substance that had the smell of opium, or even that of laudanum. I only perceived that a heap of poppy leaves that had been thrown away, exhaled an aromatic principle very analogous to that which

was

was obtained in the preceding experiment. This led me to make the following experiments.

Experiment 2. On the 3d Prairial (22d May) last, twelve leaves of the white poppy, which had attained to one third of their full growth, were well pounded in a marble mortar, without adding any liquid. The juice was very abundant, of a brown colour, slightly mucilaginous, and had but little of a bitter taste. The whole was put into a vessel of stone-ware, and exposed to the atmosphere. The temperature of the atmosphere was between 10 and 12 degrees Reaum.

On the 4th I observed a slight swelling in the mass. On the morning of the 5th it puffed up prodigiously, and already exhaled an acrid odour, very similar to that of the aroma obtained by the desiccation of the opium. On the 6th the vapour was exhaled in such large quantity, that it was impossible to approach it without becoming affected with a violent headach. On the 7th, I exposed the vessel to the sun for a space of twelve hours. The fermentation became still more vehement: I agitated the mass from time to time, attending to what happened. I soon perceived that the exhalation of the narcotic odour abated, and was partly replaced by another, which had much analogy with azotic gas; the plant and the juice acquired a deeper colour; at length they became oxydated at the expence of the surrounding air, which probably gave birth to the nitric radical, which, combined with the aroma of the plant, produced that peculiar odour of which I have been speaking.

Experiment 3. On the 24th of the same month, twelve pounds of poppy, that had arrived at about three-fourths of its growth, after having been prepared

prepared like those in the preceding experiment, were also exposed in a vessel to the air. On the 26th, the mass began to ferment, and the acrid narcotic vapour was developed in a very perceptible manner; but this time I did not expose the mass to the sun. On the 28th the smell peculiar to opium was very perceptible: I then pressed out the juice, filtrated it cold, and evaporated it, with a very moderate heat, to the consistence of an extract.

I thought I had the best grounds to expect that I should obtain real opium as the result of this experiment; but I was disappointed; for, in proportion as the juice gradually thickened, it lost its narcotic odour, and the extract which I obtained had no other smell than that peculiar to the extract obtained from inodorous plants: hence I drew the farther conclusion, that this aroma was of the same nature as that obtained in experiment 1.

Experiment 4. On the 14th of Messidor (2d July) following, I expressed two pounds of juice from poppies partly in bloom, and partly ready to blossom. This juice was of a dirty yellow colour, nearly resembling that of the *Chelidonium majus*; it had a very slight smell of laudanum, and a marked bitterness, and left a very considerable roughness upon the tongue. I exposed it to the air in a vessel of earthen-ware, in which it fermented rapidly, so that, on the 17th, it exhaled an odour similar to that of the opium of Egypt. This juice I filtrated cold, and, hoping to preserve its odour, I thickened it by exposing it in plates to the heat of the sun. The extract which I obtained still resembled that of the preceding experiment.

Experiment

Experiment 5. On the 19th Meſſidor, I extracted about one kilogramme of the juice of poppy heads, partly in flower, and partly after the leaves had fallen off, and the capſules had become very large. This juice was more bitter than that obtained in the preceding experiments. I reduced it to one-half of its quantity by the application of a very gentle heat, hoping that the maſs being more denſe, and its particles in cloſer contact with each other, I ſhould obtain, after fermentation, a ſubſtance whoſe odorous principles would be more coercible.

The juice thus inſpiſſated did not begin to ferment till the 25th, though the heat of the atmoſphere was greater than during the preceding experiments. On the 30th it had the deſired odour, and the experiment ſeemed very promiſing.

Again was I diſappointed: I reduced half of the maſs to an extract, which perfectly reſembled that obtained in experiments 3 and 4: the other half I kept in a well-corked flaſk, to be uſed in another experiment.

Experiment 6. On the 28th of Meſſidor, four hectogrammes of capſules, ſufficiently green, but arrived at their full ſize, and twelve decagrammes of the leaves and ſtalks pulled off near to the peduncle of the plant, were well bruiſed and pounded in a mortar. They yielded a thick viſcous maſs, and the juice was deeper coloured, and more bitter than that obtained in the preceding experiments. The whole being expoſed to the air in an earthen veſſel, it ſoon fermented, and four days were ſufficient to produce the evolution of an odour like that of the true oriental opium.

Of

Of this mass I preserved one-part, to be used afterwards, and inspissated the other in a temperature not exceeding 40 degrees. This extract retained a very slight smell of laudanum; it was a mixture nearly similar to the opium of commerce, excepting that the aroma had been evaporated by the heat.

It would be superfluous to describe here the numerous experiments which followed the two last-mentioned: the result in each of them was an inodorous extract, or one almost so. It is, however, proper to observe, that the pounded leaves, stalks, capsules, &c. of the poppies, always exhaled, after fermenting, for a longer or shorter period, the narcotic odour, or that of the aroma, obtained in experiment 1; but they lost it again after being exposed ten or twelve days to the air.

Before I proceed to relate other experiments, I ought to mention several remarks which I have made upon poppies, from the period at which they blossom till that when the capsule begins to grow yellow, after which they exude no more juice.

During a period of fifteen days, I made incisions, both upon the peduncule and upon the lower part of a great number of very fine poppy heads, from whence there issued a whitish-yellow juice, almost inodorous, but very bitter, which filled up the incision, and assumed a blackish colour in a very short space of time: its taste was not changed by exposure to the air, but it first acquired the acrid odour, which, in the preceding experiments, was developed by fermentation: this, however, was soon evaporated by exposure

 to

to the ſun, and the juice retained only that of laudanum.

I alſo remarked in my bed of poppies, that ſome of the capſules were of a form almoſt entirely ſpherical, whilſt others affected the oval figure.

The firſt naturally produced opium without any inciſion being made into them. This juice collected itſelf in two, three, and ſometimes four ſutures, which are found in the peduncule, where it concretes, and in a very ſhort time acquires the ſmell and colour of laudanum. I have collected ſmall maſſes of it, ſome of which weighed eight grains. I took two grains of this opium, which procured me a very tranquil and protracted ſleep. *This was drop-opium.*

All theſe poppies were ſowed on the 10th of Germinal laſt, (March 30,) in a very rich and well-manured ſoil, defended againſt the north and north-eaſt winds, by a building and a wall. The fineſt plants were at the diſtance of a foot from each other.

Nature having completed her work, I imagined alſo, according to the reſult of experiment 6, that it would be poſſible for me to attain my object, and make opium with poppies arrived at their laſt degree of maturity.

Experiment 7. For this purpoſe I took twelve fine poppy heads, ſix of which were oval and ſix globular. I pounded them together with their ſeeds, with twenty-four decagrammes of rain water. Having expoſed them to the air, in an earthen veſſel, I was very much ſurpriſed, four days afterwards, to obſerve ſpots of mould upon them. I repeatedly ſtirred the whole maſs, but

none

none of the phænomena of the preceding experiments took place: the mafs, left to itfelf, was deftroyed in the manner ufual with all vegetables.

Experiment 8. I made an extract, according to the ufual method, (by decoction), from a confiderable quantity of poppies. The decoction was faturated, and became flightly mucilaginous as it cooled, without however emitting any thing of the odour either of opium or of laudanum. I gave the extract a pulverulent confiftence: it differed effentially from thofe of the inodorous plants, poffeffing a degree of cohefion which is not ufual with thofe, and which I attributed to the refin contained in it, &c.

Experiment 9. A portion of the dried extract obtained in the preceding experiment was well triturated with a fufficient quantity of the vifcous refiduum that had been laid by in experiment 5, in order to obtain a mafs having the fame confiftence as the opium of commerce. This mixture much refembled the laudanum of the fhops in colour, tafte, and fmell.

Experiment 10. The other portion of the extract obtained in experiment 8, was likewife reduced to the confiftence of opium with the refiduum that had been laid by in experiment 6. Three days after its formation, this mafs might, by its impurities, vifcidity, colour, and tafte, have been confounded with the opium of the Levant, excepting that it was not wrapped, and in fome meafure kneaded with poppy leaves *.

* I have obferved that poppy leaves, when half dry, contract the narcotic fmell, which leads me to believe, that they are ufed in the Eaft, thus prepared, for wrapping the cakes of opium in them.

To fum up the refults of my obfervations, I am induced, by the experiments above related, to believe:

1. That the opium of commerce is not merely the extract or infpiffated juice of the ftalks, leaves, or green capfules of the poppies; for, were that the cafe, it would not contain fo large a quantity of impurities, which are diftributed in an almoft uniform manner throughout the whole mafs.

2. That this fame juice or extract, if prepared with the intervention of heat, however moderate, would not have the acrid naufeous odour, which the oriental opium retains as long as it preferves its vifcidity, as is demonftrated by experiments 3, 4, 5, and even 6.

3. That the opium of the Eaft is not the mere extract prepared by the infufion or decoction of the heads of the white poppy after it arrived at the ftage of maturity; fince that which was obtained by experiment 8 was by no means odorous, and was alfo exempt from impurities.

I fhould add, that I have had in my poffeffion capfules of the white poppy of Egypt, between which and thofe cultivated in France there appeared to me to be no difference.

4. That it appears to be made out by experiments 9 and 10, that the opium of the Eaft is the infpiffated extract of every kind of the white poppies, gathered from the time when they begin to flower till they have arrived at maturity, and afterwards mixed together, and reduced to the confiftence which is obferved in the acrid odorous mafs, obtained from the ftalks, leaves, and green capfules, of the fame kind of poppies, pounded and fermented till the moment when the acrid naufeous odour is evolved, as appears by the

the result of the above-mentioned experiments, and particularly experiment 6; and, finally, that this mass is divided into cakes, which are wrapped and kneaded at their surface with poppy leaves, in part dried, and thus sent to foreign nations.

5. That it appears, by the observations inserted between experiments 6 and 7, that there does really exist drop-opium, and that the substance which is thus termed by some natural historians, naturally exudes from that variety of the white poppy, the capsules of which affect the spherical form.

This opium differs from that of commerce by its being almost entirely soluble in water, by its purity, by its taste, which is less bitter and acrid than that of the latter, and by its odour, which is less narcotic and nauseous.

This investigation is not so complete as might be wished; and I am well aware of numerous objections that might be made against what I have advanced, such as the analysis of my opium compared with that of commerce, its medicinal properties, &c. &c. I have not the vanity to imagine that I have completed the work which I have undertaken, but its deficiencies may still be supplied. I did not think it necessary to enlarge upon the medicinal virtues of this substance. This part of the investigation is the province of the medical writer: I only assert, that the drop-opium which I obtained produced a perfect tranquillity in the system, without occasioning vertigo.

However, I do not doubt the possibility of procuring good opium from poppies cultivated in the temperate zone; and the reader is also requested

quested to observe, that those upon which I made my experiments were raised in one of the northern departments of France. I wish that the same experiments might be repeated with poppies raised in the south of the Republic. I keep a considerable number both of the spherical and oval kind, and shall with pleasure procure them for any person who may be inclined to occupy himself with this kind of labour, and to bring to perfection a work of which I have only sketched the outlines. When this shall be accomplished, we shall cease to be tributary to the foreign nations who sell us this substance at a very high price.

XXXV. *List of Patents for Inventions, &c.*

(Continued from Page 144.)

THOMAS WAKEFIELD, of Northwich, Cheshire, Esquire; for a new method of refining sugar. Dated June 2, 1801.

THOMAS WINTER, of Shacklewell, Middlesex, Gentleman; for a new manufacture for covering the floors of rooms, for covering and packing goods and merchandizes, and fit to be used for various other purposes. Dated June 2, 1801.

THOMAS HOWARD, late of Manchester, Lancashire, but now of Leeds, Yorkshire, Soap-boiler; for a new method of making a British barilla and potash, and of obtaining a greater quantity of alkali than hitherto discovered. Dated June 2, 1801.

JOSIAH

Josiah Longmore, of Birmingham, Warwickshire, Gun-lock-maker; for a patten or clog. Dated June 2, 1801.

Thomas Robert Guest, of Portsmouth, Hants, Artist; for boxes of a new and improved construction, of various forms and sizes, to contain certain new and improved materials, and other necessary articles for drawing and painting; likewise an intire new and improved method of arranging, on scientific principles, the colours to be contained in the said boxes. Which arrangement will be of the greatest utility to officers of the army, and engineers, for reconnoitering sketches or plans; to the navy for signal cards, as well as to professional men and private persons. Dated June 2, 1801.

Timothy Lane, of Lincoln's-Inn-Fields, Middlesex, late of Aldersgate-street, London, Apothecary; for measuring-glasses for compounding medicines. Dated June 5, 1801.

Egerton Smith, of Liverpool, Lancashire, Stationer, and Thomas Todd, of Liverpool, aforesaid, Organ-builder; for a method of tuning, and keeping in tune, musical and string instruments in general. Dated June 5, 1801.

William Chapman, of Newcastle-upon-Tyne, Gentleman; for the application of certain substances, either separately or combined, as a preservative of cordage. Dated June 5, 1801.

Thomas Bartlett, of Boston, in the state of Masachusetts, in North America, but at present residing in Threadneedle-street, London; for improvements in the construction of elastic trusses for ruptures. Dated June 18, 1801.

William Sellers, of Piccadilly, Middlesex, Gentleman; for a new-improved apparatus of machinery,

machinery, for the purpose of diminishing friction, and communicating a direct rotary motion from one wheel to another, by means of cranks, which he calls alternate relieving cranks, applicable to wind or water-drainage mills, or those for raising water for irregation, and various other useful purposes. Dated June 18, 1801.

G. F. Lenz, of Homerton, Middlesex, Tanner; for a method of constructing tan-pits for the tanning of hides and skins, and for striking hides by machinery. Dated June 18, 1801.

John Spencer, of Duffield, Derbyshire, Nail-master; for a new method of making horse-shoe nails. Dated June 20, 1801.

John Aloysius Senefelder, of Gould-square, London, Gentleman; for a new method and process of performing the various branches of the art of printing on paper, linen, cotton, woollen, and other articles. Dated June 20, 1801.

William Bolton, Esquire, Captain in the Royal Navy; for a rudder, and the means of preserving the same. Dated June 23, 1801.

Thomas Witherby, of Enfield, Middlesex, Gentleman; for a pump, and method of working machinery. Dated June 23, 1801.

Samuel Holemberg, of Silver-street, Bridgewater-square, London, Goldsmith; for locks and fastenings for general uses, on a new and improved construction. Dated June 24, 1801.

George Stratton, of Blackfriars Road, Surrey, Ironmonger; for improvements in machines for cooking, and fire-places. Dated June 26, 1801.

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REPERTORY OF ARTS AND MANUFACTURES.

NUMBER LXXXVIII.

Printed by Nichols and Son, Red-Lion-Paſſage, Fleet-Street, London.

XXXVI. *Specification of the Patent granted to Mr.* Walter Inglis, *of Chelmsford, in the County of Eſſex, Sadler, for a Method of forming and making a Saddle upon a new and improved Plan and Conſtruction, on which the Rider may perform longer Journies on a rough trotting Horſe, and with greater Facility and Comfort, than on any other Saddle hitherto extant; and the Stirrup-Bars are ſo contrived that ſhould the Rider, by Accident, be thrown off, or fall from, his Horſe, he will immediately upon falling be diſengaged and free.*

Dated May 21, 1801.

WITH A PLATE.

To all to whom theſe preſents ſhall come, &c. Now know ye, that I the ſaid Walter Inglis, in purſuance of, and in compliance with, the the ſaid proviſo, in the ſaid letters patent contained, do, by theſe preſents, and the drawings

in the margin hereof, deſcribe and aſcertain the nature of my ſaid invention, and the manner in which the ſame is to be performed; that is to ſay: The nature of my invention is to give elaſticity to the ſeat of the ſaddle, and conſequently eaſe to the rider, by means of a ſpring introduced into the long ſtraining web, and to attach the ſtirrup-bar to the ſaddle by means of a bolt or faſtening connected with the rider in ſuch a manner, that on falling off, or by being thrown, he draws the bolt or faſtening, and detaches the ſtirrup from the ſaddle. The manner in which this is performed is as follows: Take a common ſaddle-tree, and being provided with a ſtrong ſpring of ſteel, or other metal, (ſee Pl. XI. Fig. 2,) inſtead of fixing the long ſtrained web in the uſual manner, take a piece, of a ſufficient length, when doubled, and put over one arm of the ſpring, as at *a*, and nailed to the head of the tree in the uſual manner, will juſt ſuffer the ſpring to clear the head, and work free; the other part of the web is to go over the other arm of the ſpring at *b*, and inſtead of being nailed down on each ſide upon the bar of the ſaddle-tree, within ſide the cantle, is to be paſſed through two ſlits, to be cut in the two ſides of the cantle, about three quarters of an inch above the bar, and nailed on the lower part of the outſide of the cantle, as deſcribed in Fig. 3. By the web being thus elevated, and paſſed through the cantle, it will be allowed to play with the elaſticity of the ſpring without being preſſed down upon the tree, and in fixing this part of the long web, care muſt be taken that the ſpring be not ſtretched in doing it, nor the web left ſlack, but it muſt be drawn and

and fixed in a workman-like manner; the ſpring will then reſt in a horizontal poſition over the gullet of the ſaddle, immediately behind the head, and the long web will receive its elaſtic effect therefrom. The ſaddle in this ſtate is repreſented in the drawing Fig. 1. The ſteel ſpring, as ſeen naked in this drawing, is then to be covered with two pieces of web, each three quarters of an inch broader than the diſtance between the parts of the web already on the ſpring at *a* and *b*, and of ſufficient length to nail on each ſide on the bar of the tree. One of theſe pieces, muſt be ſtrongly ſewed underneath the ſpring to each part of the web at *a* and *b*, and the other piece over the ſpring to the web in the ſame manner, which will not only prevent the ſpring being over ſtretched, but will alſo prevent the ſtuffing of the ſaddle from interfering with it. Then ſew a piece of ſmall, but ſtrong cord or ſtring round and over the ſpring, through the parts of the web, drawing the ſtring or cord tight, and faſten both ends on the under ſide of the web, which will prevent the ſpring from being ſtretched during the croſs ſtraining. Then croſs-ſtrain the long web to a proper form, in the uſual manner, except that the croſs-ſtraining muſt not be brought quite ſo forward as the ſpring, but muſt be ſewed behind, and not upon the ſpring, ſo as not to interrupt its motion. Then proceed to finiſh the ſaddle, as uſual; and immediately previous to putting in the pannel, remove the cord or ſtring from the ſpring, and ſuffer it to have its freedom. This deſcription is equally ſufficient to enable a workman to make a lady's ſaddle, as the ſpring is to be fixed in the ſame manner.

The ſtirrup-bar conſiſts of three parts. Fig. 4, is an open box, rivetted on the bar of the ſaddle tree, a little higher than the bar, on a common tree. Fig. 5, is the ſtirrup-bar, which ſupports the ſtirrup, with a ſhort ſhank to be introduced into the box, where it is bolted by a double ſpring bolt, Fig. 6; the two prongs of which paſs through two correſponding holes in the bar and box, and thus attach the bar and ſtirrup to the ſaddle: to this bolt, Fig. 6, a ſmall ſtrap is ſewed. The rider being then ſeated is to button the ſtraps round his thighs a little above each knee; or ſhould he fall, or be thrown from his horſe, the ſtraps will draw the bolts, and the ſtirrups will immediately drop from the ſaddle. Before he diſmounts he muſt unbutton the ſtraps, or if he wiſh to try the effect of the invention, he may diſmount with the ſtraps on, when the ſpring bolts will be drawn, and the ſtirrups diſengaged from the ſaddle. Inſtead of the ſtraps going round the thighs, they may be attached to the body in any other manner, ſo as to draw the bolts on falling or being thrown. In witneſs whereof, &c.

XXXVII. *Specification of the Patent granted to Mr.* William Hase, *of Saxthorpe, in the County of Norfolk, Engineer; for a Steam-Engine on an improved Conſtruction, by which a conſiderable Reduction will be made in the Conſumption of Coals.* Dated May 14, 1801.

To all to whom theſe preſents ſhall come, &c. Now know ye, that in compliance with the ſaid proviſo,

proviso, I the said William Hase do hereby declare, that the nature of my said invention, and the manner in which the same is to be performed, are hereinafter particularly described and ascertained; that is to say: In my improved steam-engine the furnace, boiler, cylinder, piston, and moving parts in general, are constructed of such figures and dimensions, and in such relative positions, as experience has shewn to be best adapted to the intended effect of affording a first moving power, and as are well known to engineers, and other competent workmen. In which said construction I pretend to no originality, and consequently claim no exclusive privileges under the said letters patent. But whereas, in every steam-engine hitherto constructed or known, the supply of water to the boiler has been either cold, or warmed to no higher temperature than can be produced by the combination or mixture of the cold injection water with the condensed steam; which temperature, when the injection is sufficiently copious to produce a good vacuum, cannot be much elevated; I do hereby declare, that the great advantage and novelty of my said invention consist in, that the supply of water to the boiler is made at a temperature at, or very near, the boiling point, notwithstanding the injection is made in sufficient plenty to produce as perfect a vacuum as can ever be had in any steam-engine. To accomplish this desirable purpose, I cause a small or moderate sized reservoir, trough, or receptacle, to be constantly supplied with heated water, drawn out of the engine by the air-pump as usual; and I cause (by means of a small pump, or other suitable and well known apparatus) this

water

water to circulate through pipes, or other veſſels of communication diſpoſed within the pipe or paſſage leading to the condenſer, (or otherwiſe I cauſe the water to paſs on the outſide of the ſaid pipes, as may occaſionally be found convenient,) ſo that the ſteam, in its courſe to meet the injection water, muſt and ſhall neceſſarily apply itſelf in contact with the external ſurfaces of the ſaid pipes or veſſels of communication, and impart or give out much of its heat through the ſolid matter of the ſaid pipes or veſſels of communication to the water included therein, which being conveyed in its courſe again into the ſmall reſervoir, trough, or receptacle, before mentioned, will ſpeedily raiſe its contents nearly to the boiling point. In a convenient part of the ſaid pipes, or veſſels of communication, through which the ſaid heated water is urged, there may be an enlarged part, from which (or otherwiſe if there be no enlarged part, then from the ſaid pipes themſelves) a pipe muſt proceed from the boiler, forming a communication therewith, as occaſion may require, by the uſual method of a float and valve, or otherwiſe. The pipes muſt be ſo conducted or directed, with regard to the elevation of part of the included column of water, that it ſhall be eaſier for a portion of the ſaid water to flow, or be urged, into the boiler (while the valve is open) than to be driven onwards, through the whole courſe of communication, by the ſmall pump or apparatus, ſo as again to enter the reſervoir, trough, or receptacle, before mentioned. By this means a ſupply of very hot water will be always kept in readineſs during the working of the engine; of which water ſuch a portion will

will enter the boiler as the neceſſary conſumption of ſteam ſhall require, and the heat of this ſupply will be little if at all checked by the introduction of ſo much water as the reſervoir, trough, or receptacle, may alſo demand from the air-pump; in conſequence of which, the quantity of fuel required to be conſumed in order to produce a determinate quantity of ſteam will, under like circumſtances, in other reſpects, be leſs in my improved ſteam-engine than in any other. In witneſs whereof, &c.

Observations by the Patentee.

The ſaving of fuel in the above engine appears, from a variety of experiments which have been made, to amount to about one-eighth of the whole conſumption of the beſt engines hitherto made, large or ſmall; and any of Meſſrs. Boulton and Watt's ſteam engines can with eaſe be altered to receive the advantage of this improvement.

Gentlemen deſirous of adopting this invention, or of farther information reſpecting it, are requeſted to apply to the Patentee, or to Mr. Peter Keir, St. Pancras, who has the management of the buſineſs in London.

XXXVIII. *Specification of the Patent granted to Mr.* John Prosser, *of Charing Crofs, in the Parifh of Saint Martin in the Fields, in the County of Middlefex, Sword-cutler; for a Water-proof Pan and Hammer for Gun and Piftol Locks, and alfo a Breech for Gun and Piftol Barrels, for the Purpofe of a quicker and more forcible Explofion of Gunpowder.* Dated December 9, 1800.

WITH A PLATE.

TO all to whom thefe prefents fhall come, &c. Now know ye, that in compliance with the faid provifo, I the faid John Proffer do hereby defcribe and afcertain the nature of my faid invention, and in what manner the fame is to be performed, by the plan or drawing in the margin of thefe prefents, and the following defcription thereof; that is to fay: A, (fee Plate XII,) is the hammer, perforated with a large hole, a little conical, to receive the cylinder B, round which A moves forward and backward. The end, No. 1, of the hammer A, in the inner fide, has a circular groove, to receive the ward No. 2, which is on the fcrewed end of the cylinder B. This ward is for the purpofe of preventing the admiffion of any water, (which may fall between the hammer and the barrel of the gun or piftol) into the joint. The heel, No. 2, when the cock ftrikes the hammer A, falls upon the hammer fpring, and prevents the hammer A going farther round on the cylinder B than is neceffary to expofe the pan on the cylinder B. At

At the bottom of the face of the hammer A is a hole, made exactly the ſhape and ſize of the pan in the cylinder B; which hole, when the hammer A is turned round to its extent, admits the fire to fall into the pan on the cylinder B. Inſide of the end, No. 3, of the hammer A, is a female ſcrew, to receive the male ſcrew C into it, which, when ſcrewed into the end No. 3 of A, completely encloſes the end of the cylinder B, ſo as to prevent the admiſſion of water. B, is the cylinder, round which the hammer A acts, and which cylinder may be made of iron, ſteel, or metal, and is made a little conical. In this cylinder the pan and touch-hole are made; at the end of which is a male ſcrew, No. 1, of a ſmaller diameter than the cylinder. This ſcrewed end, No. 1, paſſes through the hole of the end No. 1 of the hammer A, and ſcrews into the female ſcrew of the hole No. 1 of the breech D. This ſcrew goes quite into the chamber of the breech D, and a large conical hole is made in it, quite up to the touch-hole in the pan. This hole is made ſo large as to admit with eaſe the powder that falls into the chamber into it, and brings the bottom of the charge of powder quite cloſe to the prime in the pan. The ſhoulder or ward No. 2, on the end of the cylinder B, when the cylinder B is in the hammer A, works in the circular groove, which is in the inner ſide of the end No. 1 of the hammer A, for the purpoſe before deſcribed. One ſide of the cylinder B is filed away to the ſame ſhape as the hole in the face of the hammer A, ſo as to give no impediment to the falling water of the face of the hammer A, when it is turned round over the pan. The hammer A is

 prevented

prevented falling too near the cock by having a knob of iron on the falſe breech of the barrel. The toe, No. 4, of the hammer A, works upon the uſual kind of hammer ſprings, and might be uſed either with a roller or ſwivel ſpring. The breech D is made of two parts, and are ſcrewed into each other, there being a male and female ſcrew, each half being concaved into nearly equal parts, ſo as to form an oval chamber; at the bottom of which the touch-hole is placed, and at the top the chamber is contracted, ſo as to prevent the ramrod entering into the chamber; by which means the powder is left all looſe, and free from preſſure, and conſequently will more forcibly, and with greater quickneſs, explode on the ſide of the breech D. A ſmall ſcrew, No. 2, is made to ſcrew into the ſcrewed end of the cylinder B, to prevent its turning round with the hammer A when it is operating. The above water-proof hammer and pan can be applied to any gun or piſtol already made, either ſeparate from, or in conjuction with, the breech D. The ſection E is a true repreſentation of the form of the chamber in the breech D, when both parts are ſcrewed together; and of the cylinder B, when ſcrewed into the hole No. 1 of breech D. In witneſs whereof, &c.

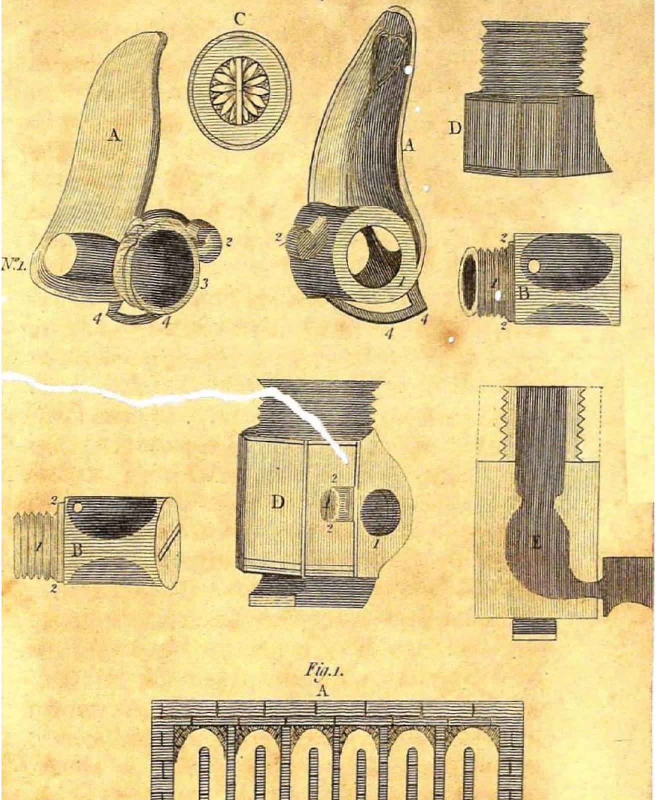
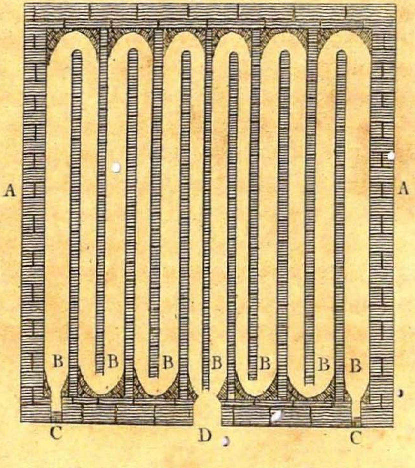


Fig.1.



XXXIX. *Specification of the Patent granted to Mr.* CHESTER GOULD, *late of Rome, in the County of Oneida, in the State of New York; but now of Red Lion-ſtreet, Clerkenwell, in the County of Middleſex, Merchant; for Improvements on his new Inſtrument or Log for aſcertaining a Ship's Diſtance at Sea; for which he obtained former Letters Patent in May laſt* *.

Dated December 17, 1800.

WITH A PLATE.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with the ſaid proviſo, I the ſaid Cheſter Gould do hereby declare that the nature of my ſaid invention of improvements, and in what manner the ſame is to be performed, are as follow; that is to ſay: My invention of improvements to my new inſtrument or log for aſcertaining a ſhip's diſtance at ſea, conſiſts of a rotator, or revolving apparatus, which I call an adjuſtable fly, and a line or chain to connect the fly with a regiſter, which may be kept on-board the veſſel, as hereafter mentioned. The fly, which contains almoſt the whole ſubſtance of my improvements, is compoſed of two or more vanes or wings, but one of four vanes or wings I conceive to be moſt proper. Theſe vanes or wings are placed both angularly and conically, ſo as to produce a rotary motion round its virtual axis or centre piece; which rotary motion may be increaſed or diminiſhed at pleaſure

* Publiſhed in our thirteenth volume, page 225.

 by

by a regulator or adjuſtment hereafter to be deſcribed. This fly, on which accuracy of meaſurement by the log wholly depends, is compoſed of regular figures, ſuch as planes and ſquares, which admit of the greateſt uniformity of workmanſhip; and its eſſential parts, together with the angular poſition of the vanes, admit of ſtrict examination, by the application of inſtruments in common uſe, ſuch as the ſquare, the compaſſes, and parallel rulers, by which very trifling errors may be eaſily diſcovered, without the trouble of experience by water. The general form of this fly being conical, it is not liable to obſtructions at ſea, from ſea weeds, or other floating ſubſtances. It is alſo detached from the regiſter for purpoſes hereafter mentioned. By the conical poſition of the vanes, I mean that poſition which is cauſed by moving their broadeſt ends from the centre in a direction with their planes, while their narrow ends remain fixed; and by the angular poſition I mean, that poſition which is cauſed by ſeparating the broad ends of the vanes from the centre, (and conſequently from each other,) in a direction at right angles with the former poſition, while the narrow ends remain fixed, as in Fig. 9, in the drawing hereto annexed, (ſee Plate XIII.); or, in other words, the conical poſition of the vanes determines the diſtance between *a* and *b*, in the ſame figure; and their angular poſition determines the diſtance between *c* and *d*, in the ſame figure. The conical poſition of the vanes being varied, increaſes or diminiſhes the rotary power or ſtrength of action of the fly, and their angular poſition being varied, increaſes or diminiſhes the number of its revolutions made in any given diſtance. The fly

is conſtructed in manner following; that is to ſay: Fig. 1, in the drawing hereto annexed, repreſents the centre piece, or virtual axis, having at its head end an eye-hole, or other convenience for faſtening the line to it, and the other end terminating in a ſcrew, of ſufficient length to vary the adjuſtment of the fly, ſo as to anſwer ſuch purpoſes as it is intended for. Fig. 2, in the aforeſaid drawing, repreſents the piece or collar, having a ſmooth hole through its centre, ſufficient to receive the axis Fig. 1, upon which it ſhould turn freely, and to which it is ſecured by a collet and pin, as in Fig. 4, in the ſame drawing. This collar muſt have the ſame number of flats or ſides as the number of vanes intended for it; and it muſt terminate conically towards its head, as in Fig. 2, in the ſame drawing. Fig. 3, in the aforeſaid drawing, repreſents the regulator. This ſhould have the ſame number of ſides with the former, and ſhould alſo terminate conically from its baſe, anſwering to the conical form of the fly. It has a tapped hole through its centre, to fit the ſcrew on the end of the axis, Fig. 1, on which it ſhould move uniformly the whole length of the ſcrew, as in Fig. 4. Figs. 5, 6, 7, and 8, in the aforeſaid drawing, repreſent the vanes, which are to be attached by their narrow ends to the ſides or flats of the collar, by ſcrews or otherwiſe, having in each of them a ſlit or opening, to admit the ſcrews which bind them to the regulator, as in Fig. 9, in the ſame drawing. As appears on vane, Fig. 5, I make a ſcale, which I graduate into ſundry parts, anſwering to the turns of the axis through the regulator; and when the fly is put together, as in Fig. 9, the ſcale reſts upon the regulator, and ſhews how far

the

the regulator is moved either way in adjuſting the fly. After having, by the aſſiſtance of the regulator, found the true poſition of the vanes, which would give the true diſtance ſailed, I have ſometimes made the fly a fixture throughout; but I prefer the adjuſtable fly.

The regiſter I uſe is conſtructed in manner following: that is to ſay: Fig. 10, in the aforeſaid drawing, repreſents the regiſter in one of its forms. It may be carried either in the veſſel's cabin, or be ſuſpended over the ſtern, by the ears *a* and *b*, in the ſame Fig. 10, ſo as to turn freely towards the fly at all times. Fig. 11, in the ſame drawing, repreſents the inſide movement or train of wheels with its dial. This is fixed within the cylinder Fig. 10, and turns the index on its dial. The pinion *d*, in the ſame Fig. 11, has upon its inner end eight leaves, which moves the firſt or contrate wheel *b*, which has forty-eight teeth; and by its pinion of ſix leaves it moves the ſecond wheel *c*, which has ſixty teeth. This wheel *c*, by its pinion of ſix leaves, moves the third wheel *d*, of ſixty teeth. This wheel *d*, by its pinion of ſix leaves, moves the fourth wheel *e* of ſixty teeth; and this wheel *e*, by its pinion of ſix leaves, moves the fifth wheel *f*, of ſixty teeth, which carries the index *g* on the end of its pinion. Its dial is graduated into one hundred diviſions, each of which anſwers to one mile, and is numbered 10, 20, 30, 40, 50, 60, 70, 80, 90, 100; and, by the addition of more wheels, in like manner, the regiſter will be capable of ſhewing any neceſſary diſtance whatever. An endleſs ſcrew would produce the ſame effect in giving motion to the regiſter as the pinion *d*, but I give the preference to the pinion. Fig. 12, in the ſaid drawing

drawing, represents the register in another form. It has a similar train of wheels as the former, with the addition of one more wheel of sixty teeth, which extends the calculation of the distance the vessel sails to a thousand miles. The form of this register, by a circular disposition of the wheels, is round, and is enclosed in a round case, which is graduated for the purpose of shewing the ship's lee way, as will be shewn hereafter. This register has three dials on its face; one of which is graduated into ten parts, answering to tenths of miles, and is numbered 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. The index on this dial moves round once every mile the vessel sails, each division counting one-tenth of a mile. The large dial is similar to the dial on Fig. 11, described above. The other of the last-mentioned three dials is also divided into ten parts, and is numbered 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000. The index on this dial moves round it once every one thousand miles, each division answering to one hundred miles. This register has an arm or cramp *a*, fixed at one of its ends to the bottom of the box, by a screw or otherwise, so as to admit of the registers turning freely upon it: and by the other end of this arm or cramp the register is secured to some convenient part of the vessel. On one-half of the outside of the circumference of the box is graduated thirty-two equal divisions, corresponding with the divisions of the compass, and an index, which is joined at one of its ends to the cramp, is brought to the edge of the box, and turned up, so as to answer the purpose of an index. When the vessel makes lee-way, the fly commonly falls to windward, nearly in proportion to that lee-way, and by the fly being to windward,

windward, the pinion of the regiſter is turned the ſame way, and brings a correſponding figure or point which is marked on the box to the before-mentioned index, and this denotes the number of points the veſſel makes to leeward.

The form and portions of the regiſter may be ſo varied as to expreſs, in other denominations of ſea-meaſure, the diſtance ſailed, if found to be more convenient than the above. And the form, ſize, and proportions of the fly may be alſo varied ſo as to accommodate it to a regiſter of any calculation. So alſo may the ſhape of the vanes be varied, if their true poſition be ſtrictly attended to, for they are all capable of variation, from any given dimenſions, and the eſſential principles are ſtill retained.

The pinions of the regiſter I generally make of bell-metal, and the other parts of the machine of braſs. Theſe materials I give the preference to; yet other materials will anſwer, provided they are of ſuch kind as will endure the effects of friction and of ſalt water. For the better illuſtration and deſcription of the fly which I uſe, and which I prefer, I have in the annexed drawings deſcribed one of four vanes, and its correſponding parts, ſhewing the proportions they bear to each other.

Fig. 1, in the ſaid drawing, repreſents the centre piece or virtual axis. This is ſix inches and an half long, and about one-fifth of an inch in diameter. On one end is a ſcrew, about two inches long, and at the other is an eye hole, to faſten the line to, as in Fig. 9. And at the diſtance of about one inch and an half from the eye hole is a collet and pin, which ſecures the collar-piece, Fig. 2, to its place.

Fig.

Fig. 2, represents the collar-piece. It is about three fourths of an inch long, and half an inch thick at the largest end, having its sides at right angles with each other, and terminating conically at its head end. It has a hole through its centre large enough to receive the centre piece or axis, to which it is screwed by the collet and pin, so that it may turn freely on the axis. See Fig. 4.

Fig. 3, represents the regulator or adjustment. This piece is about one-fourth of an inch thick. Its largest surface is an inch and an eighth of an inch over, and being a little tapering, its smallest surface is left an inch over. It has a tapped hole through its centre, fitted to the screw on the end of the axis, where it belongs, as in Fig. 4.

Figs. 5, 6, 7, and 8, represent the four vanes. These are all of equal strength, and about a sixteenth part of an inch thick; they resemble in form a right-angled triangle, whose base is eight inches, and whose perpendicular is three inches. A piece is cut off from the acute angle, which leaves the end about half an inch wide. A piece also must be cut out from the right angle, running nearly parallel with the base, sufficient to prevent the vanes crossing the centre, and thereby counteracting each other. The piece cut from the fly I am describing is about one inch and three-fourths of an inch long, and half an inch wide; and must be varied according to the proportions of the fly. The vanes must be perfectly flat, and uniformly alike.

I make a scale, which is before described on Fig. 5, on which scale are the Figs. 2, 4, 6: under which figures are twenty divisions, answering each to one turn of the axis through the regulator or adjustment; and when the outer edge of the

the regulator or adjuſtment ſtands at the diviſion againſt Fig. 4, in the aforeſaid ſcale, the fly is ſuppoſed to be rightly regulated or adjuſted; but if, on trial, it is found otherwiſe, then, by turning the axis, the regulator or adjuſtment is moved, and the motion of the fly altered at pleaſure. Moving the regulator or adjuſtment towards Fig. 6, in the ſcale, increaſes the motion of the fly: and moving the regulator or adjuſtment towards Fig. 2, in the ſcale, diminiſhes the motion. Every turn of the axis, either way, alters the motion of the fly about three miles in an hundred. The opening in the vanes ſhould be of ſufficient length to give freedom to the ſcrews which bind the vanes to the regulator or adjuſtment when it is moved.

Fig. 4, repreſents the three firſt mentioned parts; that is to ſay, Figs. 1, 2, and 3, put together, and the vanes being attached to the four flats or ſides of the collar piece compleat the fly, as deſcribed in Fig. 9. The fly being thus compleated, the vanes ſtand both in a conical and angular poſition, with regard to their centre or axis, and incline the fly to turn but one way; and as their angular poſition is increaſed or diminiſhed, ſo will be the number of revolutions of the fly in ſailing any given diſtance.

For particular purpoſes the motion of the fly may be increaſed two, three, and even four times faſter than is uſual. This may be done either by enlarging the regulator or adjuſtment, or moving it farther towards the collar piece, ſo as to extend the broad ends of the vanes farther from the axis or centre, that is, farther aſunder; in which caſe the ſame regiſter will ſtill anſwer, if read accordingly. If the fly is conſtructed agreeably

ably to the size and proportions here given, and is accurately regulated or adjusted, so as to give the true distance sailed, the broad ends of the opposite vanes will be an inch and three-eighths of an inch asunder. And in case of any accident that the fly may meet with at sea, or otherwise, the above distance, being examined by a pair of compasses, will be a direction to the mariner how to restore the fly to its former accuracy of measurement, the narrow ends of the vanes that are attached to the collar piece remaining fixed.

The line, which I prefer to a chain, should be made of good materials, be well twisted, and about the size of a common log line. The line connects the fly and register together. Its length should be in proportion to the size of the vessel, that the fly may be so far distant from the stern of the vessel as not to be effected by the eddy of the vessels wake, which is often found to extend from fifteen to twenty-five fathoms astern. One end of the line is fastened to the pinion of the register, which, in Figs. 10 and 12, is marked *a*, and the other end is fastened to the head end of the fly. See Fig. 9.

The fly is towed perpetually after the vessel at sea, and its revolutions are communicated to the register by the line, and these in exact proportion to the velocity of the vessel through the water.

There should be no impediment or obstruction about the line to prevent its turning freely, or about the register to prevent it from turning the pinion to which the line is fastened in a direction with the fly, especially when the vessel's lee-way is necessary to be known.

 The

The log, as now improved, and ufed, has the properties and advantages over my former log, hereinafter mentioned; that is to fay:

The fly of the improved log has an eafy and efficacious mode or principle of regulation, by which its motion may be altered at pleafure, and with great uniformity and precifion. But my former log did not poffefs thefe advantages in fo perfect a degree.

The fly of the improved log, on which all accuracy of meafurement depends, is, as beforementioned, compofed of regular figures, fuch as planes and fquares, which admit of the greateft uniformity and exactnefs in the workmanfhip of it; and its effential parts, and their true pofitions, admit of ftrict examination by the application of inftruments in common ufe, fuch as the fquare, compaffes, and parallel-ruler: and, by the help of thefe, trifling errors may be difcovered and corrected without the trouble of experiments by water. Thefe conveniencies my former log was quite deftitute of. The improved log has a fly particularly adapted to very flow motion of the veffel, when fhe fails lefs than two miles an hour, which is alfo to be ufed when the veffel is lying to the wind in bad weather, and drifting, to give the diftance fhe drifts an hour, as is above defcribed, and the fame regifter anfwers for this fly alfo. But my former log being heavier, was inclined to fink in flow motion, and was alfo deficient in its power of action in flow failing, which could not be remedied without enlarging the machine too much for common ufe, or without increafing the friction to a degree that would wear out the machine in a fhort time. The improved log may have two

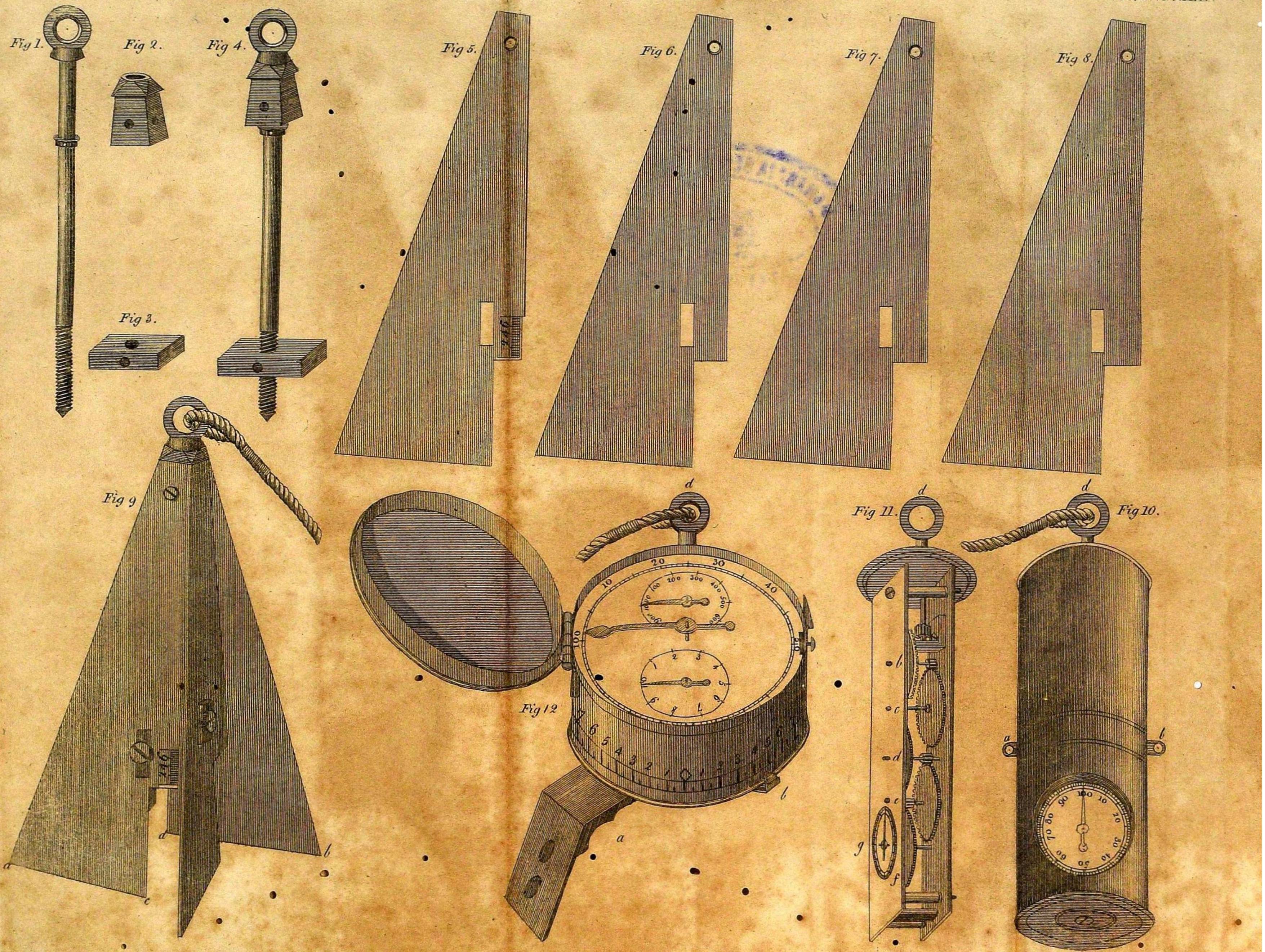


Fig 1.
Fig 2.
Fig 4.
Fig 3.
Fig 5.
Fig 6.
Fig 7.
Fig 8.
Fig 9
Fig 12
Fig 11.
Fig 10.

two or more flies with one register, the fly being an inconsiderable part of the expence of the whole machine, in which case, if one fly is lost, it may be easily replaced; but if an accident of this kind happened to my former log, the injury could not easily be repaired. This circumstance renders the improved log much more convenient in practice, and its most expensive part, namely the register, less liable to be lost, and less liable to accidents. It is also more durable, as the train of wheels or register is kept clean and dry. It is also more certain in its performance, not being so liable as my former log to obstructions at sea, by sea weeds, or other floating substances. The improved log is more portable and convenient for conveyance, its construction is less expensive, and it is more easily understood and repaired by common mechanicks.

When there is no obstruction between the fly and the box, it shews on the box of the register the number of points lee-way the vessel makes; but this valuable acquisition could not be derived from my former log. The register of the improved log is kept on-board the vessel, in which the distance sailed can at all times be seen. Whereas the whole of my former log went in the water, and the register of it could not be seen without taking it into the vessel. In witness whereof, &c.

XL. *Description of a Malt and Corn Kiln invented by Mr.* Joseph Coppinger, *of Harbour View, near Cove, Ireland. Communicated by him in a Letter to the Editors.*

WITH A PLATE.

THE enclosed plan of a malt and corn kiln, for which I have been favoured with the thanks of the Bath Society, at a general meeting, held in September last, is particularly adapted to the use of farmers, who, in wet seasons, often lose quantities of grain for want of such convenience. The advantages it appears to me to possess above the kiln now in common use are many; first, it may be erected for one-tenth of the expence, if you take in the value of the separate buildings which are now almost invariably allotted for this purpose. Secondly, any kind of fuel may be used without prejudice to the malt or corn to be dried in it. Thirdly, the heat (by the construction of the flues) will be more regularly and evenly distributed without any waste, as at present. Fourthly, the health of the people attending will not, as at present, be exposed to certain injury, by always breathing and sleeping in a heated and unwholesome atmosphere, as their beds will be placed in a shed on the outside of the building. This, in my mind, is the most important part of the plan, and highly worthy the attention of every humane and considerate employer in this way. Fifthly, this construction of a kiln may be erected on a loft or ground floor. If in the latter situation, sufficient elevation

tion ſhould be given the fire-place, ſo as not to impede the draught. Theſe are the principal advantages that occur to me. If the experience of others confirm them, I ſhall be highly gratified.

Reference to the Plan.

(See Plate XII.)

A, main walls.

B, the flues.

C, the chimnies; in each of which may be placed a metal damper, to regulate the heat. It is recommended, in the caſe of a new building, to carry up the flues of the chimnies in the thickneſs of the walls. In a houſe already built, they may be carried up either inſide or outſide the building.

D, the fire-place, which may be divided or in one, juſt as deſired; by which the half or the whole may be heated.

Kiln tiles, eighteen inches ſquare, and two inches thick in the ſolid, with a lapping of half an inch broad and one inch deep round the edge of each tile, are propoſed for covering the flues, which, if fairly caſt, may be laid dry, without mortar. If it ſhould be difficult, or too expenſive, to procure tiles of eighteen inches, nine inches can be made to anſwer. The flues are propoſed to be divided by a brick, on edge, ſo as that every eighteen inch tile will cover two flues. The breadth of the flues may be ſix inches and an half, and ten inches high. This proportion, it is hoped, will be found to anſwer in moſt caſes; but it may be varied according to the better judgment of the party erecting. The

ſides

ſides and bottoms of the flues ſhould be plaſtered. The platform of this kiln ſhould, in all caſes, be well rammed with earth, and made perfectly level before laying out the flues.

Iron grate doors are intended to be hung on hinges, in a receſs, at the mouth of each flue, to prevent them being choaked with large pieces of cinder, or other ſubſtances. It is intended that theſe doors ſhould ſhut and open at pleaſure, as may be found neceſſary.

XLI. *Account of a Method of generating Yeaſt. By the Rev.* WILLIAM MASON, *of Aſton, near Rotheram; communicated in Letters to the Secretary of the Society for the Encouragement of Arts, Manufactures, and Commerce; and alſo of ſome Experiments on this Subject by a Committee of Chemiſtry.*

From the TRANSACTIONS of the SOCIETY.

A Bounty of Twenty Pounds was given to his Servant JOSEPH SENIOR, *to whom the Diſcovery was firſt owing.*

MY ſervant who brews for me having impregnated wort with fixed air, or rather a decoction of malt in water, according to Dr. Henry's ingenious method, mentioned in the Memoirs of the Philoſophical Society of Mancheſter, and by the yeaſt thereby obtained produced good bread. This led him, unknown to me, to try whether the

the experiment would not succeed full as well without fixed air; which he found it did. He accordingly brought me a small vessel with a full head of yeast upon it, assuring me, with some degree of exultation, that neither oil of vitriol with chalk, nor any portion of old yeast, had been employed on the occasion. This greatly surprised me; and I then desired he would proceed with the experiment in his own way, and endeavour to increase the quantity already made, by what additional decoction of malt and water he might think proper; insisting only that nothing but malt, water, and heat, should be employed for the purpose. He did so, and in a few days increased the original quantity till it became sufficient to work a hogshead of small-beer, which produced ten pounds weight of perfect yeast; and this, being soon after put on a vat for a hogshead of ale, was found to be augmented to forty-two pounds.

The discovery therefore is simply this: "that "yeast is not (as has, I believe, been hitherto "thought) some peculiar and unknown sub"stance, necessary to be added to wort in order "to put it into a fermenting state; but that malt "boiled in water will generate it (as the chemists "say) *per se*, if the following circumstances be "attended to.

"1st, That the process be begun with a small "quantity of the decoction.

"2dly, That it be kept in an equal degree of "heat. And,

"3dly, That, when the fermentation is be"gun, it should be assisted and augmented with "fresh decoctions of the same liquor."

The proportions and method which my ſervant has found generally to ſucceed, I will now give you, as taken from his own words, in the form of a recipe.

Procure three earthen or wooden veſſels of different ſizes and apertures, one capable of holding two quarts, the other three or four, and the third five or ſix: boil a quarter of a peck of malt for about eight or ten minutes in three pints of water; and when a quart is poured off from the grains, let it ſtand in a cool place, till not quite cold, but retaining that degree of heat which the brewers uſually find to be proper when they begin to work their liquor. Then remove the veſſel into ſome warm ſituation near a fire, where the thermometer ſtands between 70 and 80 degrees (Fahrenheit), and there let it remain till the fermentation begins, which will be plainly perceived within thirty hours; add then two quarts more of a like decoction of malt, when cool, as the firſt was; and mix the whole in the larger-ſized veſſel, and ſtir it well in, which muſt be repeated in the uſual way, as it riſes in a common vat: then add a ſtill greater quantity of the ſame decoction, to be worked in the largeſt veſſel, which will produce yeaſt enough for a brewing of forty gallons.

As I cannot conveniently ſend my ſervant to town on this occaſion to produce the yeaſt himſelf, and have alſo ſome doubt whether the ſimplicity of the proceſs will not make it diſregarded, I have thought it beſt to communicate the diſcovery previouſly to you, who, as my friend told me, appeared to be intereſted in its ſucceſs; hoping you may be induced to try ſo eaſy an experiment,

periment, and to acquaint me with the reſult of it, before you communicate it to the Society. With my brewer it has never failed, except when the failure was to be accounted for from an inequality of temperature of the air, where the experiments were made: it ſeems therefore to me, that in the hands of a good practical brewer, accommodated with a place where his little vat will ſtand in a conſtant degree of proper heat, it will generally ſucceed, eſpecially in the brewing ſeaſons.

P. S. It may be proper to add, that my ſervant is of opinion, that a proper quantity of hops boiled in the liquor makes the fermentation proceed better; but as it may, and has actually ſucceeded, without ſuch addition, I would willingly wiſh them to be omitted, to prevent the bread baked with it from taſting bitter. Experience only can decide this; and farther experience is ſtill wanted, to make a perfect recipe for the operation.

In a ſecond letter Mr. Maſon ſays, that "yeaſt, "uſed for the purpoſe of brewing malt liquor, "and in making bread, is a viſcid frothy ſubſtance, which ariſes on the ſurface of a ſimple "decoction of malt in water, when in a ſtate of "fermentation; and which ſubſtance, after it has "been ſo generated, may, by additional quantities of the ſame liquor, gradually ſupplied, "be increaſed *ad infinitum*." This definition, duly attended to, will put the committee on their guard in adjudging the premium to any perſon who, by adding any known or unknown article to wort, offers it as a ſubſtitute for old yeaſt taken from a former brewing, becauſe they will

be taught that new original yeaſt may be obtained from wort itſelf without any ſuch ſubſtitute.

With reſpect to the doubt you expreſſed in your obliging anſwer to my laſt, I can with truth aſſure, that in all the primary decoctions made hitherto for the purpoſe, coarſe earthen and *glazed* pots have been uſed, till a quantity of yeaſt ſufficient to work a brewing of beer was produced: after which, the proceſs was carried on in a large wooden vat; and therefore, when I uſed in my laſt the epithet *wooden* as well as earthen, it was merely becauſe I thought the former kind of veſſels leſs liable to accidents.

Certain it is, that in two experiments lately made here, in York, one by myſelf, the other by my friend Dr. Burgh, a gentleman much more converſant in chemical matters than myſelf, new earthen veſſels bought out of the ſhops were employed.

He produced excellent bread from the yeaſt which his decoction had generated, without any addition of hops: a ſmall quantity of hops were boiled in mine; which, without much affecting the taſte of the bread baked with it, left about four gallons of table beer, now in a ſmall caſk; which, though not fine, from having been brewed little more than a fortnight, is greatly preferable to the wretched bitter beverage ſold by our common brewers, from whoſe vats a yeaſt is produced, equally unpalatable for the purpoſe of baking, and perhaps equally unwholeſome both for baking and brewing.

I am much obliged to you for the attention which you promiſe to pay to the experiment; but I cannot help wiſhing that you had at your elbow one of our old houſewives in one of our

obſcure

obſcure Yorkſhire dales, uſed, as they are, to very ſmall brewings, who, after two or three little blunders, would ſoon bring it to a certainty.

In another letter Mr. Maſon ſays, I write to inform you of the reſult of ſome more experiments which have been made here, under my direction, relative to yeaſt; and the rather, becauſe they were made by means of a very ſimple apparatus, which I think will be found very convenient on ſhip-board, and alſo in cottages, &c. It is merely a wooden box, of about twelve or fourteen inches ſquare, open on one ſide, in which a veſſel containing the wort is placed; and then the box is ſet with the open ſide cloſe to a wall, heated by a fire on the other ſide, when the thermometer indicates the wall to be about 80°: ſo that I imagine the back of a chimney in a ſhip, or behind an oven or kitchen fire in a cottage, would be found very convenient for the proceſs; as the veſſel might be there ſurrounded with a ſmall atmoſphere of air, ſufficiently warm at the firſt, and capable of being continued at the ſame equable temperature for a ſufficient time.

A box of this kind, in which the following experiments were made, was placed on a dreſſer in my kitchen, more than eighteen feet from the kitchen fire, but againſt a thin wall, which divides the kitchen from the ſervants hall, juſt behind the fire-place of that room; and the open ſide of the box turned to the heated wall, the veſſels themſelves uncovered. If you recollect the trouble you ſo obligingly took in heating your office, you will think this method, ſince diſcovered, of performing the ſame experiment, of conſiderable utility.

Experiment

Experiment I. Three veſſels were ſet at the ſame time in the warm box, containing a quart of liquor each, and of equal ſtrength with reſpect to malt: one was a decoction without hops, another with hops, the other a ſimple infuſion of malt: in about twenty-four hours the hopped decoction produced a fine head of yeaſt; the other decoction fermented as well, but was twenty-four hours later; the ſimple infuſion was near thirty-ſix hours later, and the yeaſt appeared dark and ill-coloured, ſo that my houſekeeper thought it ſpoiled; but this bad appearance was merely owing to its not having been boiled and cleared, for it made very light breakfaſt rolls.

This experiment, you will perceive, was made to try whether hops (as my ſervant imagined) were neceſſary; and it certainly proves that they accelerate the fermentation; but it proves alſo, that neither hops nor boiling are eſſential to the proceſs.

Experiment II. Four veſſels from a common brewing of ale were placed in a box of longer dimenſions; one contained two quarts; a ſecond, one; a third, a pint; a fourth, half a pint: they all ſhewed ſigns of fermentation at the ſame time, *viz.* in about twenty-four hours; but that in the mug or pot holding a pint appeared the ſtrongeſt, which my ſervant thought was owing to the ſmaller diameter of the veſſel, which was ſmaller in proportion to the half-pint; but as it ſtood more centrally to the heat of the fire behind, I am perſuaded the exceſs of fermentation proceeded from that cauſe. This proves that the quantity you begin the proceſs with is not very material: though two quarts ſeem to be moſt convenient for the purpoſe of baking.

Experiment

Experiment III. was inftituted merely to find whether an addition of fugar would accelerate the fermentation; for which purpofe, two quarts of hopped liquor were tried in feparate veffels, a quart in each: and the refult was, that the decoction, in which two large fpoonfuls of coarfe fugar were ftirred in, did not ferment in the leaft, though continued in the warm box five days and nights; the other fermented in about thirty-fix hours. The reafon of this later fermentation than of that in the former experiments, was, that the liquor ufed was from a brewing of fmall-beer. Hence we may conclude, that a decoction of the ftrength of ale, if not of ftrong-beer, is the beft to begin with.

Account of Experiments on the Generation of Yeaft, made under the Infpection of the Committee of Chemiftry of the Society.

Four quarts of ground malt were put into a new ftone-ware veffel, and mafhed, with about an equal quantity of hot water, in the ufual manner for brewing.

When the mafh had ftood about an hour, the wort was drawn off, and three quarts of boiling water poured on the grains: when this had ftood a due time, the liquor was fuffered to run off, and the whole liquor, boiled half an hour, being then fet to cool, was poured clear from the fediment, and then put in a room where the heat was regularly kept up to fummer heat, or near 80° of Fahrenheit's thermometer. It ftood in this degree of heat till fome figns of fermentation appeared on the furface; which came on in about three days.

Another

Another brewing was then made as above described; and, when of a due heat, stirred into the former liquor. In about twenty-four hours some yeast appeared, and another brewing was then made; and, when of a due heat, mixed with the two former ones, and well beat in, the heat being still kept up to the degree above mentioned: in about two days more, five ounces of excellent yeast were collected from the surface of the liquor.

Some of this yeast being mixed with a due proportion of flour, water, and salt, answered all the purposes intended for bread; and might certainly have been equally well applied to brewing, in the common method. In fine, being pure and good yeast, it will answer all the intentions of that useful article.

XLII. *Observations relative to the Means of increasing the Quantities of Heat obtained in the Combustion of Fuel. By Count* RUMFORD.

From the JOURNALS of the ROYAL INSTITUTION of GREAT BRITAIN.

IT is a fact which has been long known, that clays, and several other incombustible substances, when mixed with sea coal, in certain proportions, cause the coal to give out more heat in its combustion than it can be made to produce when it is burnt pure or unmixed; but the cause of this increase

increafe of heat does not appear to have been yet inveftigated with that attention which fo extraordinary and important a circumftance feems to demand.

Daily experience teaches us that all bodies,—thofe which are incombuftible,—as well as thofe which are combuftible, and actually burning,—throw off in all directions heat,—or rather calorific (heat-making) rays, which generate heat wherever they are ftopped, or abforbed;—but common obfervation was hardly fufficient to fhow any perceptible difference between the quantities of calorific rays thrown off by different bodies, when heated to the fame temperature, or expofed in the fame fire; although the quantities fo thrown off might be, and probably are, very different.

It has lately been afcertained, that when the fides and back of an open chimney fire-place, in which coals are burned, are compofed of fire-bricks, and heated red-hot, they throw off into the room incomparably more heat than all the coals that could poffibly be put into the grate, even fuppofing them to burn with the greateft poffible degree of brightnefs. Hence it appears that a red-hot burning coal does not fend off near fo many calorific rays as a piece of red-hot brick or ftone, of the fame form and dimenfions; and this interefting difcovery will enable us to make very important improvements in the conftruction of our fire-places, and alfo in the management of our fires.

The fuel inftead of being employed to heat the room *directly*, or by the direct rays from the fire, fhould be fo difpofed, or placed, as *to heat the back and fides of the grate*; which muft always be

constructed of fire-brick or fire-stone, and *never of iron, or of any other metal.* Few coals, therefore, when properly placed, make a much better fire than a larger quantity; and shallow grates, when they are constructed of proper materials, throw more heat into a room, and with a much less consumption of fuel, than deep grates; for a large mass of coals in the grate arrests the rays which proceed from the back and sides of the grate, and prevents their coming into the room; or, as fires are generally managed, it prevents the back and sides of the grate from ever being sufficiently heated to assist much in heating the room, even though they be constructed of good materials, and large quantities of coals be consumed in them.

It is possible, however, by a simple contrivance, to make a good and an œconomical fire in almost any grate, though it would always be adviseable to construct fire-places on good principles, or to improve them by judicious alterations, rather than to depend on the use of additional inventions for correcting their defects.

To make a good fire in a bad grate, the bottom of the grate must be first covered with a single layer of balls, made of good fire-bricks, or artificial fire-stone, well burnt, each ball being perfectly globular, and about $2\frac{1}{2}$ or $2\frac{3}{4}$ inches in diameter. On this layer of balls the fire is to be kindled, and, in filling the grate, more balls are to be added with the coals that are laid on; care must, however, be taken in this operation to mix the coals and the balls well together, otherwise, if a number of the balls should get together in a heap, they will cool, not being kept red-hot by the combustion of the surrounding fuel, and the

fire

fire will appear dull in that part; but if no more than a due proportion of the balls are uſed, and if they are properly mixed with the coals, they will all, except it be thoſe perhaps at the bottom of the grate, become red hot, and the fire will not only be very beautiful, but it will ſend off a vaſt quantity of radiant heat into the room; and will continue to give out heat for a great length of time. It is the opinion of ſeveral perſons who have for a conſiderable time practiſed this method of making their fires, that more than one-third of the fuel uſually conſumed may be ſaved by this ſimple contrivance. It is very probable that, with careful and judicious management, the ſaving would amount to one-half, or fifty *per cent.*

As theſe balls, made in moulds, and burnt in a kiln, would coſt very little, and as a ſet of them would laſt a long time, — probably ſeveral years, — the ſaving of expence in heating rooms by chimney fires, with bad grates, in this way, is obvious; but ſtill it ſhould be remembered, that a ſaving quite as great may be made by altering the grate, and making it a good fire-place.

In uſing theſe balls, care muſt be taken to prevent their accumulating at the bottom of the grate: as the coals go on to conſume, the balls mixed with them will naturally ſettle down towards the bottom of the grate, and the tongs muſt be uſed occaſionally to lift them up; and, as the fire grows low, it will be proper to remove a part of them, and not to replace them in the grate till more coals are introduced: — a little experience will ſhow how a fire made in this manner can be managed to the greateſt advantage, and with the leaſt trouble.

Balls, made of pieces of any kind of well-burnt hard brick, though not equally durable with fire-brick, will anſwer very well, provided they be made perfectly round; but if they are not quite globular their flat ſides will get together, and, by obſtructing the free paſſage of the air amongſt the coals, will prevent the fire from burning clear and bright.

The beſt compoſition for making theſe balls, when they are formed in moulds, and afterwards dried and burnt in a kiln, is pounded crucibles mixed up with moiſtened Sturbridge clay; but good balls may be made with any very hard burnt common bricks, reduced to a coarſe powder, and mixed with Sturbridge clay, or even with common clay. The balls ſhould always be made ſo large as not to paſs through between the front bars of a grate.

Theſe balls have one advantage, which is peculiar to them, and which might perhaps recommend the uſe of them to the curious, even in fire-places conſtructed on the beſt principles; they cauſe the cinders to be conſumed almoſt entirely; and even the very aſhes may be burnt, or made to diſappear, if care be taken to throw them repeatedly upon the fire when it burns with an intenſe heat. It is not difficult to account for this effect in a ſatisfactory manner; and in accounting for it we ſhall explain a circumſtance on which it is probable that the great increaſe of the heat of an open fire, where theſe balls are uſed, may, in ſome meaſure, depend. The ſmall particles of coal, and of cinder, which, in a common fire, fall through the bottom of the grate, and eſcape combuſtion, when theſe balls are uſed can hardly fail to fall and lodge on ſome

of

of them; and, as they are intenſely hot, theſe ſmall bodies, which alight upon them in their fall, are ſoon heated red-hot, and diſpoſed to take fire and burn; and as freſh air from below the grate is continually making its way upwards amongſt the balls, every circumſtance is highly favourable to the rapid and complete combuſtion of theſe ſmall inflammable bodies. But if theſe ſmall pieces of coal and cinder ſhould, in their fall, happen to light upon the metallic bars which form the bottom of the grate,—as theſe bars are conductors of heat, and, on account of that circumſtance, as well as of their ſituation,—*below* the fire,—never can be made very hot,—any ſmall particle of fuel that happens to come into contact with them, not only cannot take fire, but would ceaſe to burn ſhould it arrive in a ſtate of actual combuſtion.

Theſe facts are very important, and well deſerving of the attention of thoſe who may derive advantage from the improvement of fire-places, and the œconomy of fuel.

There are ſome circumſtances which ſtrongly indicate that an admixture of incombuſtible bodies with fuel, and eſpecially with coal, cauſe an increaſe of the heat, even when the fuel is burnt in a cloſed fire-place. No fire-place can well be contrived more completely cloſed than thoſe of the iron ſtoves in common uſe in the Netherlands; but, in theſe ſtoves,—which are heated by coal fires,—a large proportion of wet clay is always coarſely mixed with the coals before they are introduced into the fire-place. If this practice had not been found to be uſeful, it would certainly never have obtained generally; nor would

would it have been continued, as it has been, for more than two hundred years.

The combination of different subſtances,—combuſtible and incombuſtible,—to form, artificially, various kinds of cheap and pleaſant fuel, particularly adapted for the different proceſſes in which the fuel is employed, is a ſubject well worthy the attention of enterpriſing and ingenious men. How much excellent fuel, for inſtance, might be made with proper additions, and proper management, of the mountains of refuſe coal-duſt that lie uſeleſs at the mouths of coal pits; and how much would it contribute to cleanlineſs, and elegance if the uſe of improved coke, or of hard and light fire-balls, could be generally introduced in our houſes and kitchens, inſtead of crude, black, powdery, dirty ſea-coal.—Of the great œconomy that would reſult from ſuch a change there cannot be the ſmalleſt doubt.

It is a melancholy truth, but, at the ſame time, a moſt undiſputable fact, that, while the induſtry and ingenuity of millions are employed, with unceaſing activity, in inventing, improving, and varying thoſe ſuperfluities which wealth and luxury introduce into ſociety, no attention whatever is paid to the improvement of thoſe common neceſſaries of life on which the ſubſiſtence of all, and the comforts and enjoyments of the great majority of mankind, abſolutely depend.

Much will be done for the benefit of ſociety, if means can be deviſed to call the attention of the active and benevolent to this long-neglected, but moſt intereſting ſubject.

XLIII. *On the Use of Steam as a Vehicle for conveying Heat from one Place to another.* *By Count* Rumford.

(Concluded from Page 190.)

Each *steam tube* must descend perpendicularly from the *horizontal conductor* with which it is connected to the level of the bottom of the *containing vessel* to which it belongs; and, moreover, must be furnished with a good brass cock, perfectly steam-tight; which may best be placed at the height of about six feet above the level of the floor of the room.

This *steam tube* may either descend *within the vessel* to which it belongs, or *on the outside of it*, as shall be found most convenient. If it comes down on the outside of the vessel, it must enter it at its bottom, by a short horizontal bend; and its junction with the bottom of the vessel must be well secured, to prevent leakage. If it comes down into the vessel, on the inside of it, it must descend to the bottom of it, or at least to within a very few inches of the botttom of it; otherwise the liquid in the vessel will not be uniformly and equally heated.

When the steam tube is brought down on the inside of the containing vessel, it may either come down perpendicularly, and without touching the sides of it, or it may come down on one side of the vessel, and in contact with it.

When several steam tubes, belonging to different containing vessels, are connected with one and the same horizontal steam conductor, the upper end of each of these tubes, instead of being simply

ſimply attached by ſoldering to the under ſide of the conductor, muſt enter at leaſt one inch within the cavity of it; otherwiſe the water reſulting from a condenſation of a part of the ſteam in the conductor, by the cold air which ſurrounds it, inſtead of finding its way back into the ſteam boiler, will deſcend through the ſteam tubes and mix with the liquids in the veſſels below; but when the open ends of theſe tubes project upwards within the ſteam conductor, though it be but to a ſmall height above the level of its under ſide, it is evident that this accident cannot happen.

It is not neceſſary to obſerve here, that, in order that the ends of the ſteam tubes may project within the *horizontal conductor*, the diameters of the former muſt be conſiderably leſs than the diameter of the latter.

To prevent the loſs of heat ariſing from the cooling of the different tubes through which the ſteam muſt paſs in coming from the boiler, all thoſe tubes ſhould be well defended from the cold air of the atmoſphere, by means of warm covering; but this may eaſily be done, and at a very trifling expence. The horizontal conductors may be encloſed within ſquare wooden tubes, and ſurrounded on every ſide by charcoal duſt,—fine ſawduſt,—or even by wool;—and the ſteam tubes, and prime conductor, may be ſurrounded, firſt by three or four coatings of ſtrong paper, firmly attached to them by paſte or glue, and covered with a coating of varniſh, and then by a covering of thick coarſe cloth. It will likewiſe be adviſable to cover the horizontal conductors with ſeveral coatings of paper, for if the paper be put on to them while it is wet with the paſte or glue, and if care be taken to put it on in long ſlips or bands,

bands, wound regularly round the tube in a ſpiral line, from one end of it to the other, this covering will be uſeful, not only by confining more effectually the heat, but alſo by adding very much to the ſtrength of the tube, and rendering it unneceſſary to employ thick and ſtrong ſheets of metal in the conſtruction of it.

However extraordinary and incredible it may appear, I can aſſert it as a fact, which I have proved by repeated experiments, that if a hollow tube, conſtructed of ſheet copper $\frac{1}{20}$ of an inch in thickneſs, be covered by a coating only twice as thick, or $\frac{1}{10}$ of an inch in thickneſs, formed of layers of ſtrong paper, firmly attached to it by good glue, the ſtrength of the tube will be *more than doubled* by this covering. I found by experiments, the moſt unexceptionable and deciſive—of which I intend at ſome future period to give to the public a full and detailed account,—that the ſtrength of paper is ſuch, when ſeveral ſheets of it are firmly attached together with glue, that a ſolid cylinder of this ſubſtance, the tranſverſe ſection of which ſhould amount to only one ſuperficial inch, would ſuſtain a weight of 30,000 lb. avoirdupois, or above 13 tons, ſuſpended to it, without being pulled aſunder or broken. The ſtrength of hemp is ſtill much greater, when it is pulled equally, in the direction of the length of its fibres. I found, from the reſults of my experiments with this ſubſtance, that a cylinder of the ſize above-mentioned, compoſed of the ſtraight fibres of hemp, glued together, would ſuſtain 92,000 lb. without being pulled aſunder.

A cylinder, of equal dimenſions, compoſed of the ſtrongeſt iron I could ever meet with, would not ſuſtain more than 66,000 lb. weight; and the

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iron muſt be very good not to be pulled aſunder with a weight equal to 55,000 lb. avoirdupois.

I ſhall not, in this place, enlarge on the many advantages that may be derived from a knowledge of theſe curious facts. I have mentioned them now in order that they may be known to the public; and that ingenious men, who have leiſure for theſe reſearches, may be induced to turn their attention to a ſubject, not only very intereſting, on many accounts, but which promiſes to lead to moſt important improvements in mechanics.

I cannot return from this digreſſion without juſt mentioning one or two reſults of my experimental inveſtigations relative to the force of coheſion, or ſtrength of bodies, which certainly are well calculated to excite the curioſity of men of ſcience.

The ſtrength of bodies of different ſizes, *ſimilar in form*, and compoſed of the *ſame ſubſtance*,—or the forces by which they reſiſt being pulled aſunder by weights ſuſpended to them, and acting in the direction of their lengths, *are not in the ſimple ratio of the areas of their tranſverſe ſections*, or of their *fractures*;—but in a higher ratio;—and this ratio is different in different ſubſtances.

The *form* of a body has a conſiderable influence on its ſtrength, *even when it is pulled in the direction of its length*.

All bodies, even the moſt brittle, appear to be *torn aſunder*, or their particles ſeparated, or fibres broken, *one after the other*; and hence it is evident, that that *form* muſt be moſt favourable to the ſtrength of any given body, pulled in the direction of its length, which enables the greateſt number of its particles, or longitudinal fibres, to be ſeparated to the greateſt poſſible diſtance—ſhort of that at which the force of coheſion is over-

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come,—before any of them have been forced beyond that limit.

It is more than probable that the apparent ſtrength of different ſubſtances depends much more on the number of their particles that come into action before any of them are forced beyond the limits of the attraction of coheſion, than on any ſpecific difference in the intenſity of that force in thoſe ſubſtances.

But to return to the ſubject more immediately under conſideration.—As it is eſſential that the ſteam employed in heating liquids, in the manner before deſcribed, ſhould enter the containing veſſel at, or very near, its bottom, it is evident that this ſteam muſt be ſufficiently ſtrong, or elaſtic, to overcome, not only the preſſure of the atmoſphere, but alſo the additional preſſure of the ſuperincumbent liquid in the veſſel; the ſteam boiler muſt, therefore, be made ſtrong enough to confine the ſteam, when its elaſticity is ſo much increaſed by means of additional heat, as to enable it to overcome that reſiſtance. This increaſe of the elaſtic force of the ſteam need not, however, in any caſe, exceed a preſſure of five or ſix pounds upon a ſquare inch of the boiler, or *one third part, or one half*, of an atmoſphere.

It is not neceſſary for me to obſerve here, that in this and alſo in all other caſes, where ſteam is uſed as a vehicle for conveying heat from one place to another, it is indiſpenſably neceſſary to provide *ſafety valves* of two kinds;—the one for letting a part of the ſteam eſcape, when, on the fire being ſuddenly increaſed, the ſteam becomes ſo ſtrong as to expoſe the boiler to the danger of being burſt by it;—the other for admitting air into the boiler, when, in conſequence of the di-

minution of the heat, the ſteam in the boiler is condenſed, and a vacuum is formed in it; and when, without this valve, there would be danger, either of having the ſides of the boiler cruſhed, and forced inwards by the preſſure of the atmoſphere from without; or of having the liquid in the containing veſſels forced upwards into the horizontal ſteam conductors, and from thence into the ſteam boiler. This laſt-mentioned accident, however, cannot happen, unleſs the cocks in ſome of the ſteam tubes happen to be open. The two valves effectually prevent all accidents.

The reader will, no doubt, be more diſpoſed to pay attention to what has here been advanced, on this intereſting ſubject, when he is informed that the propoſed ſcheme has already been executed on a very large ſcale, and with complete ſucceſs; and that the above details are little more than exact deſcriptions of what actually exiſts.

A great mercantile and manufacturing houſe at Leeds, that of Meſſrs. Gott and Company, had the courage, notwithſtanding the mortifying prediction of all their neighbours, and the ridicule with which the ſcheme was attempted to be treated, to erect a *dying-houſe*, on a very large ſcale indeed, on the principles here deſcribed and recommended.

On my viſit to Leeds the laſt ſummer, I waited on Mr. Gott, who was then mayor of the town, and who received me with great politeneſs, and ſhowed me the cloth halls, and other curioſities of the place; but nothing he ſhowed me intereſted me half ſo much as his own truly noble manufactory of ſuperfine woollen cloths. I had ſeen few manufactories ſo extenſive, and none ſo complete

complete in all its parts. It was burnt to the ground the year before I saw it, and had just been rebuilt, on a larger scale; and with great improvements in almost every one of its details. The reader may easily conceive, that I felt no small degree of satisfaction on going into the dying-house to find it fitted up on principles which I had had some share in bringing into repute, and which Mr. Gott told me he had adopted in consequence of the information he had acquired in the perusal of my *seventh* essay. He assured me that the experiment had answered, even far beyond his most sanguine expectations; and, as a strong proof of the utility of the plan, he told me, that his next door neighbour, who is a dyer by profession, and who, at first, was strongly prejudiced against these innovations, has lately adopted them, and is now convinced that they are real improvements. Mr. Gott assured me that he had no doubt but that they would be adopted by every dyer in Great Britain in the course of a very few years.

The dying-house of Messrs. Gott and Company, which is situated on the ground-floor of the principal building of the manufactory, is very spacious, and contains a great number of coppers of different sizes; and as these vessels, some of which are very large, are distributed about promiscuously, and apparently without any order in their arrangement, in two spacious rooms,—each copper appearing to be insulated, and to have no connection whatever with the others,—all of them together form a singular appearance. The rooms are paved with flat stones, and the brims of all the coppers—great and small—are placed at the same height—about three feet—above

above the pavement: ſome of theſe coppers contain upwards of 1800 gallons; and they are all heated by ſteam from one ſteam boiler, which is ſituated in a corner of one of the rooms.

The horizontal tubes which ſerve to conduct the ſteam from the boiler to the coppers are ſuſpended juſt below the cieling of the rooms: they are made—ſome of lead—and ſome of caſt-iron; and are from four to five inches in diameter; but when I ſaw them, they were naked, or without any covering to confine the heat. On my obſerving to Mr. Gott that coverings for them would be uſeful, he told me that it was intended that they ſhould be covered, and that coverings would be provided for them.

The vertical *ſteam tubes*, by which the ſteam paſſes down from the horizontal *ſteam conductors* into the coppers, are all conſtructed of lead, and are from $\frac{3}{4}$ of an inch to $2\frac{1}{2}$ inches in diameter; being made larger or ſmaller, according to the ſizes of the coppers to which they belong. Theſe ſteam tubes all paſs down on the *outſides* of their coppers, and enter them horizontally at the level of their bottoms. Each copper is furniſhed with a braſs cock, for letting off its contents; and it is filled with water from a ciſtern at a diſtance, which is brought to it by a leaden pipe. The coppers are all ſurrounded by thin circular brick walls, which ſerve not only to ſupport the coppers, but alſo to confine the heat.

The rapidity with which theſe coppers may be heated, by means of ſteam, is truly aſtoniſhing. Mr. Gott aſſured me that one of the largeſt of them, containing upwards of 1800 gallons, when filled with cold water from the ciſtern, requires no more than *half an hour* to heat it till it actu-

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ally boils! — By the greateſt fire that could be made under ſuch a copper, with coals, it would hardly be poſſible to make it boil in leſs than an hour.

It is eaſy to perceive, that the *ſaving of time* which will reſult from the adoption of this new mode of applying heat will be very great; — and it is likewiſe evident, that it may be increaſed, almoſt without limitation, merely by augmenting the diameter of the ſteam tube: care muſt, however, be taken that the boiler be ſufficiently large to furniſh the quantities of ſteam required. — The *ſaving of fuel* will alſo be very conſiderable: Mr. Gott informed me, that, from the beſt calculation he had been able to make, it would amount to near two-thirds of the quantity formerly expended, when each copper was heated by a ſeparate fire.

But theſe ſavings are far from being the only advantages that will be derived from the introduction of theſe improvements in the management of heat: there is one, of great importance indeed — not yet mentioned — which alone would be ſufficient to recommend the very general adoption of them. — As the heat communicated by ſteam can never exceed the mean temperature of boiling water by more than a very few degrees, the ſubſtances expoſed to it can never be injured by it. In many arts and manufactures this circumſtance will be productive of great advantages, but in none will its utility be more apparent than in cookery; and eſpecially in public kitchens, — where great quantities of food are prepared in large boilers; for, when the heat is conveyed in this manner, all the labour now employed in ſtir-

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ring about the contents of those boilers, to prevent the victuals from being spoiled by the burning to the bottoms of them, will be unnecessary; and the loss of heat occasioned by this stirring prevented; and, instead of expensive coppers, or metallic boilers, which are difficult to be kept clean, and often stand in need of repairs — common wooden tubs may, with great advantage, be used as culinary vessels; and their contents may be heated by *portable fire-places*, by means of steam boilers attached to them.

As these portable fire-places and their steam boilers may, without the smallest inconvenience, be made of such weight, form, and dimensions, as to be easily transported from one place to another by two men, and be carried through a doorway of the common width — with this machinery, and the steam tubes belonging to it, and a few wooden tubs, — a complete public kitchen, for supplying the poor and others with soups, and also with puddings, vegetables, meat, and all other kinds of food prepared by *boiling*, might be established in half an hour, in any room, in which there is a chimney (by which the smoke from the portable fire-place can be carried off); and, when the room should be no longer wanted as a kitchen, it might, in a few minutes, be cleared of all this culinary apparatus, and made ready to be used for any other purpose.

This method of conveying heat is peculiarly well adapted for heating baths: it is likewise highly probable that it would be found useful in the bleaching business, and in washing linen. It would also be very useful in all cases where it is required to keep any liquid at about the boiling point

point for a long time without making it boil; for the quantity of heat admitted may be very nicely regulated by means of the braſs cock belonging to the ſteam tube. Mr. Gott ſhowed me a boiler in which ſhreds of ſkins were digeſting in order to make glue, which was heated in this manner; and in which the heat was ſo regulated, that, although the liquid never actually boiled, it always appeared to be upon the very point of beginning to boil.

This temperature had been found to be beſt calculated for making good glue. Had any other *lower* temperature been found to anſwer better, it might have been kept up with the ſame eaſe, and with equal preciſion, by regulating properly the quantity of ſteam admitted.

I need not ſay how much this country is obliged to Mr. Gott, and his worthy colleagues. — To the ſpirited exertions of ſuch men — who abound in no other country — we owe one of the proudeſt diſtinctions of our national character; — that of being an enlightened and an enterpriſing people.

XLIV. *An easy and accurate Method of adjusting the Glasses of* Hadley's *Quadrant, on Land for the Back Observation.*

By Mr. ROBERT PATTERSON.

From the TRANSACTIONS of the AMERICAN PHILOSOPHICAL SOCIETY.

THERE are few if any instruments, of modern invention, of more extensive use in the measuring of angles, than that invented by our countryman, Mr. Godfry, but which has unjustly got the name of Hadley's quadrant.

I have, however, often regretted, that for want of some easy and accurate method of adjusting the glasses for the back-observation, practicable on land, and applicable to the *common octant*, this instrument was still so much limited in its use. For when an angle exceeding 90 degrees is to be measured, or when an altitude of the sun, &c. exceeding 45 degrees is to be taken, by means of a reflecting horizontal surface, and such cases frequently occur, then we must either have recourse to the back-observation, or to some other instrument.

In order to remedy, in some measure, this inconvenience, the sextant, without any glasses for the back-observation, has been introduced; but even this instrument is incapable of measuring an altitude, by means of a reflecting horizontal surface, as above, when exceeding 60 degrees; and this will be the case with the meridian altitude of the sun, in most parts of the United States, during four months in the year.

Various

Various methods of adjusting the glasses for the back-observation have indeed been proposed; but these are either very inaccurate and troublesome, or inapplicable to the common octant, and require some appendage to the instrument, with which but very few have yet been made.

The following method of making this adjustment will not, I flatter myself, be found liable to any of the above objections.—It may be, made on land, in a few minutes, at any time of the day when the sun shines; requires no additional apparatus, but what any person may readily make for himself; and the adjustment may be relied upon as equally accurate with that for the fore-observation.

Description of the necessary Apparatus.

Take a piece of plane glass (a piece of looking-glass will do very well)—take the polish off one side of it, and cement it, with the rough side down, on the flat side of the segment of a wooden ball. The ball may be about three or four inches in diameter, and the piece of glass of about the same dimensions. Or the glass may be cemented to a piece of board, and this board to a three or four pound shot, or small hand-granade, when either of these may be conveniently had.

Next take a piece of triangular board, of about four inches on the side, and through this cut a triangular mortice of about two inches on the side. Near the corners of this board let there be inserted three small nails, or pieces of wire, to serve as feet for it to stand on.

Method of making the Adjuſtment, or finding the Quantity of the Index-Error.

At any time when the ſun ſhines ſet your triangular board on a table, the cill of a window, or any other convenient ſtand expoſed to the ſun, and place the ball, with the piece of glaſs, on the triangular mortice; which, touching the ball only in three points, will conſequently keep it ſteady in any poſition. Turn the ball into ſuch a poſition that the plane of the glaſs may be, as nearly as you can judge, parallel to the equator; and then incline this plane, in the direction of the meridian paſſing through the ſun, till the ſun be about 45° above it.

Now take your octant, and, by the fore-obſervation, bring one of the limbs of the ſun's image, ſeen by a double reflection from the ſpecula of the inſtrument, exactly into contact with the image of the ſame limb, ſeen by a ſingle reflection from the ſurface of the glaſs plane, and read off the angle pointed out by the index. Immediately turn round your inſtrument, and bring the ſame limbs into contact by the back obſervation. If the angle now pointed out by the index be exactly the ſupplement (to 180°) of the former angle, the horizon-glaſs for the back-obſervation will be truly adjuſted, or exactly at right angles with the horizon-glaſs for the fore-obſervation: but if theſe two be not equal, then take half their difference, which will be the correction or index-error for the back-obſervation; ſuppoſing the fore-horizon-glaſs to have been previouſly well adjuſted. This correction will be additive to all angles meaſured by the back-obſervation, when the angle pointed out by the index in the firſt of

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the above-obſervations is greater than the ſupplement of the other, and *vice verſa.*

For the ſake of greater accuracy, you may repeat theſe obſervations till you have taken two, four, or ſix ſets: obſerving that if in your firſt ſet you begin with the fore-obſervation, as above directed, then in your ſecond ſet you muſt begin with the back-obſervation, and ſo on. A mean of the corrections thus obtained may be taken as the *true* correction of adjuſtment.

I ſhall conclude this paper with the following miſcellaneous remarks, relative to this ſubject.

1. If the arch of exceſs beyond 90° be but ſmall, as in ſome octants is the caſe, then it may be neceſſary to place the index one or two degrees before the 0, on the extra arch, and adjuſt the fore-horizon-glaſs to this poſition of the index. You will thus obtain a greater range for the index in adjuſting the back-horizon-glaſs.

2. When the reflecting glaſs plane is placed in the poſition above-mentioned, *viz.* at right angles to the plane of the meridian paſſing through the ſun, then the ſun's path in the heavens will, for ſeveral minutes, be very nearly parallel to the ſaid plane; and therefore no ſenſible error is to be apprehended from the increaſe or decreaſe of the ſun's altitude above this plane during the interval between the firſt and ſecond obſervations in the ſame ſet. But even if this ſhould be the caſe, from the glaſs plane being placed conſiderably *out* of the above poſition, yet, by conducting the obſervations as above directed, the ſmall errors ariſing from this ſource will naturally correct one another.

3. When the poliſh is taken off one ſurface of a piece of glaſs, then the image of the ſun, being reflected only from one ſurface, will appear ſin-

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gle and distinct; whereas the image reflected from both surfaces will, most frequently, appear double or indistinct; arising from the want of parallelism between the surfaces.

4. The image of the sun seen by a single reflection from one surface of the glass plane, and that seen by a double reflection from the specula of the instrument, will both appear nearly of the same shade or degree of brightness; and this will seldom be so intense as to require any screen or coloured glass to be interposed between the eye and the image.

5. In making observations with this instrument, whether for the purpose of adjusting the glasses, or for any other purpose, where great accuracy is required, it is necessary that the point on the index-speculum from which the first reflection is made, that on the horizon-glass from which the second reflection is made, and the eye-hole through which the image is viewed, be all in a plane, parallel to the plane of the instrument. This will be effected by wrapping a piece of tape, or the like, round the index speculum, leaving only a bare strip, of about a quarter of an inch broad, parallel to the plane of the instrument, and at the same height above it as the eye-hole, and transparent part of the horizon-glass.

6. The eye-hole is generally made too small. In measuring angles on land, as in the practice of surveying, (for which purpose this instrument is much preferable to any other in common use,) in taking altitudes at sea, in measuring the angular distance of the sun and moon, but especially of the moon and a star; the eye has generally need of all the light that can be admitted from the object seen by direct vision. — The eye-hole, therefore,

therefore, ſhould, I think, be nearly as large as the ordinary ſize of the pupil of the eye; nor is any inaccuracy, in this caſe, to be apprehended from the line of viſion not being parallel to the plane of the inſtrument; the eye being capable of placing itſelf, with great exactneſs, oppoſite the *centre* of the eye-hole.

The ſame objection and remedy are applicable to the ſlits in the ſight-vanes, of the common ſurveying inſtruments.

7. Mr. Maſkyline, and others, recommend the ſun itſelf as the beſt object by which to adjuſt the fore-horizon-glaſs.—There is however conſiderable difficulty attending this mode of adjuſtment.—The ſun is too bright to be viewed directly without a piece of coloured glaſs interpoſed between it and the eye; and even if the eye-piece be furniſhed with ſuch an appendage, (which in the common octant is ſeldom the caſe,) ſtill the two images will be of very different ſhades; and either the one ſeen by direct viſion will be too bright, or that ſeen by reflection will be too faint, for an accurate obſervation of their coincidence or contact.—This difficulty may, however, be obviated in the following manner.

Every octant is furniſhed with at leaſt two coloured glaſſes, of different ſhades—take the darkeſt of theſe out of its frame, and with a thread faſten it on *behind* the horizon-glaſs, and turn down the other, between this and the index-ſpeculum: the two images of the ſun will thus be generally of the ſame ſhade, or nearly ſo, and the adjuſtment may then be made with the utmoſt eaſe and ſafety to the eye. Or, which is perhaps better,—Place your eye behind the fore-horizon-glaſs, and, looking through this towards the cen-

tre

tre of the index-speculum, hold the instrument in such a position as that the line of vision may be directed to any point in the heavens, &c. at the angular distance of 90 degrees from the sun; and then, the index being placed at o, two images of the sun will appear, both by a single reflection, one from the index-speculum, and the other from the back part of the fore-horizon-glass; and by bringing these images into coincidence or contact, as when you look directly at the sun, the adjustment may be made, or the index-error found, with great ease and exactness. If the images of the sun should be too bright for the eye, one of the coloured glasses belonging to the instrument may be held before the eye. The two images of the sun, thus viewed, will appear nearly of the same shade, since the one, from the index-speculum, which would otherwise appear the brightest, will lose part of its light by passing through the horizon-glass.

After all, I am of opinion, that this adjustment may be made with equal accuracy, and much more ease, by any well-defined object on land, as the edge of a chimney, the roof of a house, or the like, at a sufficient distance.

Any one may satisfy himself that this is the case, by repeatedly measuring the error of adjustment in the common way, *viz.* by moving the index till he produces an apparent coincidence between the object seen directly, and by reflection. If a chimney, or the like, be the object viewed, he will scarce ever find any of these errors to differ from the mean error more than *one minute*; and the difference of such errors, when the sun is used, will not be less, but generally greater.

If

If the diſtance between the index-ſpeculum and the line of direct viſion (*viz.* a line joining the eye-hole and horizon-glaſs) ſhould not exceed three inches, which it ſeldom does, then the parallax of the inſtrument will not amount to a quarter of a minute, and may therefore be ſafely neglected; provided the object viewed be at the diſtance of two-thirds of a mile. If a ſuitable object, at ſuch a diſtance, cannot be readily found, then you may take one at any given diſtance, and compute the parallax to be allowed for that diſtance, thus — Multiply the conſtant number 95 (the nat. tang. of 1′ to rad. $\frac{1}{36}$) by the diſtance, in inches, of the centre of the index-ſpeculum above the line of direct viſion, and dividing the product by the diſtance of the object in yards, the quotient will be the parallax of the inſtrument, or correction of adjuſtment, for that diſtance in minutes. For example, if the height of the index-ſpeculum above the line of viſion be three inches, and the diſtance of the object 150 yards: then $\frac{95 \times 3}{150} = 1'.9$ will be the error of adjuſtment. If, therefore, you place the index ſo much behind the o, on the limb of the inſtrument, and then adjuſt the horizon-glaſs by an object at the above diſtance, the adjuſtment will be true for an object conſidered as at an infinite diſtance.

From the above rule it is obvious, that much exactneſs in meaſuring or eſtimating the diſtance of the object you adjuſt by is not neceſſary, provided that diſtance be not very ſmall; for, in the above example, an error in the diſtance even of ten yards would have produced an error of no more than about $\frac{1}{10}$ of a minute in computing the parallax of the inſtrument.

8. In meaſuring angles by this inſtrument, when the object ſeen by direct viſion is at no great diſtance, the parallax of the inſtrument muſt be taken into conſideration. In ſuch caſes it is commonly recommended previouſly to adjuſt the horizon-glaſs by that object; but this, in the back-obſervation, would be attended with very great difficulty—it will therefore be beſt always to keep the back-horizon-glaſs at the ſame adjuſtment, and make the neceſſary correction, as above directed, for the diſtance of the object.

XLV. *Obſervations on the Preparation of the Citric Acid. By Profeſſor* PROUST.

FROM THE *JOURNAL DE PHYSIQUE.*

A FRIEND of mine, Don Antonio Hernandez del Valle, ſecretary to the conſulate at the Havannah, wrote to me (in the year 1795) during the ſtay which he made at Cadiz, before he embarked, to requeſt me to give him ſome inſtructions with reſpect to the preſervation of lemon-juice during long voyages, informing me that he had never been able to ſucceed in preſerving it to the ſatisfaction of the crew. His knowledge of chemiſtry having ſuggeſted to him the deſign of making ſome inveſtigations with reſpect to this ſubject, he perſuaded me to make ſome experiments upon this acid alſo, in order that he might unite them with thoſe which he intended to make himſelf after he had arrived at the place of his deſtination.

What I am about to offer to the reader will add nothing to our knowledge of the nature of the

the acid of the lemon, as the indefatigable Scheele has exhaufted this fubject. My defign is only to fubject his formula for the extraction of this acid to fixed data, and to inveftigate whether or not the fubftances, that are obftacles to its prefervation, are of fuch a nature that they can be feparated from it by means lefs dependant upon the arts of the laboratory.

The lemon-juice which I ufed had been clarified by filtration, and kept for the fpace of a year in the cellar, covered with a little oil, as is cuftomary in the laboratories.

I. Spirit of wine, mixed in a pretty large proportion with this juice, did not render it turbid, even after it had ftood for twenty-four hours.

I evaporated, with a very gentle heat, three pounds to the confiftence of a fyrup, and found, like Scheele, that the acid fhewed no difpofition to cryftallize, even when the evaporation had been carried fo far, that the juice was almoft of the confiftence of an extract. This proceeds, without doubt, from the circumftance, that this acid, though very capable of forming cryftals, requires only a very fmall quantity of water for its cryftallization.

Lemon-juice acquires, by evaporation, the colour, and rather difagreeable odour peculiar to extracts of plants. Rediffolved in water, it produces a juice which ftill retains the flavour of vegetable extracts. In fhort, evaporation, whilft it leaves us no poffibility of feparating the principles that alter the quality of the lemon-juice, is attended with the inconvenience common to all extracts; namely, that, by diffolving them in water, we can never reftore to them the flavour of the frefh juices of the plants.

Dubuiſſon tells us; in the ſupplement to his *Art du Diſtillateurs*, that the evaporation of lemon-juice with a gentle heat cauſes a depoſition of its mucilage, and renders it capable of being preſerved. I perceived nothing of this kind, nor was I ſurpriſed; for the mucilage and extractive matter are not of that nature that they can be ſeparated in any ſuch manner. The latter, in particular, does not belong to thoſe ſubſtances which quit their ſolvent, and form a pellicle, in conſequence of the inſolubility which they acquire by being ſaturated with oxygen. Lemon-juice prepared in this manner might certainly keep very well, but where? only in our cellars — not in the hold of a veſſel, ſailing under the Equinoctial line.

It is cuſtomary, as Don Hernandez informed me, to boil the lemon-juice to a conſiderable degree before ſhipping it; but beſides that it acquires an empyreumatic flavour, it is no leſs apt to ferment in the bottles, and crack them when the veſſels approach the line.

II. The concentration of lemon-juice by the action of the froſt, which was propoſed by Georgius, has not been found more ſucceſsful. Moreover, this proceſs deſtroys neither the mucilage nor the extractive matter of the juice; and, beſides that it is not practicable in the countries where the lemon tree grows, theſe being hot climates, it is evident, that this ſyrup cannot be more capable of ſupporting the heat, to which it is expoſed in voyages, than that which has been prepared with the application of heat.

III. Dr. Brugnatelli informs us, that lemon-juice, diſſolved in ſpirit of wine, depoſits a part of its mucilage within a few days. He adds, that after

after the alkohol has been ſeparated by diſtillation, we have the acid both pure and concentrated. It ſeems, however, that this proceſs does not yet accompliſh its purpoſe; for, we may aſk the author, what has become of the extractive matter which Scheele diſcovered to exiſt in the juice of the lemon?

I wiſhed to try the diſcolouring power of powdered charcoal, ſo much extolled, and ſo much diſputed in Germany, upon ſome lemon-juice, of a pretty high colour; but the reſult did not confirm the truth of what has been related concerning this proceſs.

From this inveſtigation it appears, that, excepting the formula of Scheele, we are not yet in poſſeſſion of the means of ſeparating the mucilage and extractive matter of lemon-juice; and that we muſt keep to this, until a ſimpler proceſs ſhall be diſcovered.

IV. Lemon-juice evaporated to the conſiſtence of a ſyrup, and diluted with ſeven or eight times its quantity of ſpirit of wine, becomes turbid, and depoſits a ſubſtance of a browniſh colour, and gluey conſiſtence, which is completely ſoluble in water. This is pure mucilage.

This ſpirituous mixture, when diſtilled in a retort, leaves the juice of the ſame conſiſtence and colour; and though it has loſt its mucilage, it cannot yet be rendered cryſtallizable by evaporation; for its extractive matter, ſoluble in water, ſtill remains combined with it. The juice uſed in theſe experiments indicated between 5 and 6 degrees of Beaume's areometer. When dried as much as was poſſible, without altering its quality, it yielded 48 grains *per* ounce of dry matter.

V. Four

V. Four ounces of white chalk were heated with one pound of water in a ſilver baſin. It was afterwards ſaturated, by pouring ſucceſſive quantities of lemon-juice upon it, for a conſiderable time after it had ceaſed to effervefce. When brought to this ſtate, about an ounce more of juice was added to it, in order that one might be certain that the earthy ſubſtance was completely ſaturated. This proceſs required 94 ounces of the juice.

When this mixture had cooled, the liquid was poured off from above the citrate, which occupied the bottom of the baſin. This was afterwards waſhed three or four times with cold water, in order to ſeparate the whole of the extractive matter that remained combined with it; by which means ſeven ounces and half a gros of white calcareous citrate, of a pulverulent conſiſtence and light, were obtained.

This liquid, ſeparated from the citrate that was combined with the water uſed in the lixiviation, was evaporated to a certain point, by which means three and a half gros more of citrate were obtained. The product of citrate was conſequently not more than 7 oz. 4 gros; and if we add half a gros more, which I ſuppoſe to have been what remained in the evaporated liquids, the total amount will not be more than ſixty gros and a half of this citric ſalt.

VI. As the citric acid, whilſt it unites with the chalk, expels the carbonic acid, it is neceſſary that we ſhould know to what quantity the latter amounts, in order that we may aſcertain the quantity of citric acid that ſupplies its place.

Analysis of the Chalk.

One hundred parts, converted into lime by calcination, were reduced to 56½ parts. The loss of acid and water therefore amounts to 43½ *per cent.* One hundred parts of the same chalk, dissolved by nitric acid, lost only between 40 and 41 parts of carbonic acid. This earth therefore contains water in the proportion of 3 *per cent.* The nitric acid also separated from it 3 parts *per cent.* of argill, which was slightly ferruginous. The component parts of a quintal of the chalk may therefore be arranged in the following table.

Argill, ...	3	parts.
Water, . . .	3	
Carbonic acid, . .	40½	
Lime, ...	53½	
Total, . .	100	

We have consequently in 4 ounces, or 32 drachms of chalk, the following quantities, within very small fractions.

Argill, ...	1	
Water, ...	1	
Carbonic acid, . . .	12¾	
Lime, ...	17¼	
Total, . .	32	drachms.

Hence it appears, that the earthy base, which 32 drachms of chalk furnish to 60½ drachms of citrate,

citrate, amounts to 17¼ drachms of lime or 18¼ drachms, if we include the argill.

It appears alſo, that the citric acid, which has taken the place of 12¾ drachms of carbonic acid, amounts to 41½ drachms. If we add to theſe 58½ drachms of pure citrate 2 drachms of water and argill, we ſhall have for the total product 60½ drachms.

From theſe proportions we find, by calculation, that a quintal of citrate ought to contain 30⅔ parts of lime, mixed with a little argill: but having calcined a hundred parts of this citrate, it yielded 31½ of lime, a proportion very near to that above mentioned; and if we deduct 1½ of argill from the lime, we ſhall have in the quintal of citrate

Lime, . .	30
Citric acid, .	70
	100

But the quantity of real acid will be leſs than the whole of the water with which it can be combined in the citrate: this, however, I have not attempted to verify.

The citrate of chalk, as Scheele has remarked, has little ſolubility in water, and its ſolution has no marked flavour. It is not rendered turbid by admixture of ſpirit of wine; and it produces no alteration in the tincture of tourneſol, or a ſolution of the ſulphate of potaſh: the fluoric, phoſphoric, and boracic acids, produce no impreſſion upon it; but the oxalate of potaſh and the oxalic acid precipitate the lime from it.

The extractive ley contains, beſides mucilage and extract, calcareous malate, which is imme-

diately precipitated by ſpirit of wine, when it has been condenſed by evaporation.

The colour of lemon-juice is not altered by admixture with a few drops of nitrate of iron, for the exceſs of acids rediſſolve the gallate, where the combination of iron is of an aſtringent quality; but if we deprive it of this exceſs of acid by means of potaſh, it exhibits the vinous colour, though in a ſlight degree.

The calcareous citrate, kept under water, and expoſed to the ſun during the heats of ſummer, putrefies; and the water becomes covered with ſtony cruſts, which are carbonate of lime. Like the other vegetable acids, the citric acid is deſtroyed by putrefaction. Its carbonous principle, reunited with the oxygen of the decompoſed water, and converted into acid, reproduces the chalk. During this putrefaction, air bubbles continually ariſe, which can be nothing elſe than carbonous hydrogen.

VII. *Decompoſition of the calcareous Citrate by ſulphuric Acid.*

In order completely to diſlodge the carbonic acid of 4 ounces of chalk, it was neceſſary to employ 20 ounces of diluted ſulphuric acid, indicating 19 degrees of Beaume's areometer.

This acid is prepared by mixing 3 parts of water with 1 of the oil of vitriol of commerce; if the oil is not ſufficiently concentrated, the proportion of water is diminiſhed, and the acid brought to the indicated point of ſtrength.

It is evident, therefore, that the above-mentioned quantity of ſulphuric acid ought to be

ſufficient to ſeparate the citric acid united with a baſe of 4 ounces of chalk. This quantity conſequently amounts to five times the weight of the citrate, or 500 to 100 of this earthy ſalt.

I boiled 6 ounces of citrate with 2 pounds of water, and added 30 oz. of my ſulphuric acid at 19 degrees. After the ebullition had continued for half a quarter of an hour, taking care to ſtir the mixture with a ſpatula, the whole of the citrate was converted into calcareous ſulphate. The mixture was filtrated through blotting-paper, and put to evaporate: it depoſited ſulphate, and it required four ſucceſſive evaporations and filtrations to free it entirely of its earthy depoſitions.

We may accelerate the ſeparation of this ſulphate, by mixing the liquor evaporated to the conſiſtence of a clear ſyrup with a certain quantity of ſpirit of wine. This is the proceſs which ought to be followed, whenever, not wiſhing to extract a large quantity of citric acid, we want to have it as pure as poſſible.

The conſiſtence of a clear ſyrup is not yet the point at which the citric acid can cryſtallize; for this purpoſe it is neceſſary to reduce it to the conſiſtence of a boiled ſyrup, and that becauſe this acid unites with very little water in its cryſtallizations. By two cryſtallizations I obtained 3 ounces and a half, or 28 drachms, of pretty large cryſtals. The two drachms which were wanting to complete the thirty, which, according to the proportions above eſtabliſhed, ought to be furniſhed by the ſix ounces of citrate, remained in the mother-water. But as it did not appear to me that there could be more than half a drachm in this reſiduum, it is evident that the citric acid will

will be, as I have mentioned above, 2 or 3 less than 70 *per cent.*

VIII. Although the citrate be white and well lixiviated, it is still combined with a small quantity of extractive matter, the colour of which reappears, after its decomposition, in the liquors. Hence it is difficult to obtain white crystals, without at least two new crystallizations. The habitudes of the calcareous citrate are, in this respect, the same as those of other earths and earthy salts, which easily combine with colouring particles. The citrate that can be separated from verjuice by means of chalk, is particularly liable to this inconvenience. If we do not immediately separate it from the liquor, it assumes a violent colour, of which we cannot deprive it by repeated lixiviations.

An ounce of the lemon-juice employed in the subsequent experiments, evaporated by exposure to the sun, left 48 grains of a dry residuum. But the citric acid having been found to be 34, the extract, the gum, and a small quantity of malic acid, form together 14 grains. These 48 grains of different principles are therefore diluted with 3 oz. 7 dr. 24 grs. of water; that is to say, they form one-ninety-fourth part of the lemon juice.

IX. *Conclusions.*

It follows, from these investigations, that the mucilage and extractive matter are, as was discovered by Scheele, the corruptible or fermentable principles of the lemon-juice. None of the processes proposed for its concentration having been found proper for depriving it of these principles, we are obliged to have recourse to the method of

this author. This method would be very practicable upon a large ſcale; but it would require baſins of ſilver or fine tin. It is abſolutely neceſſary that all earthen veſſels glazed with lead ſhould be baniſhed from the manufactory; but not thoſe of *fayence*, for the lead which forms a part of their glazing is vitrified to that degree that it can no longer be attacked by the acid.

Let us conſider a little on each of the principles of the lemon-juice with reſpect to fermentation. Strictly ſpeaking, none of them is ſeparately capable of paſſing into the ſpirituous fermentation, and not even into the acid. The extractive matter of this juice tends even to become mouldy very ſoon. Nevertheleſs, when they are found naturally mixed with ſaccharine juices, ſuch as thoſe of the grape, the apple, the cherry, elderberries, &c. they paſs very readily into a ſtate, which, if it is not their ſpirituous fermentation, is at leaſt a ſtate which enſures the common preſervation of all theſe principles. Let us take, for example, the juice of the currant, which is one of thoſe which, on account of the exceſs of their acid, produce only a bad wine, that contains little ſpirit.

This juice conſiſts of mucilage, gelatinous matter, extract, ſugar, the citric, malic, &c. acids, and water. If we diſpoſe it for fermentation in a hot ſeaſon, the fermentation takes place only in a very languid manner, for the ſugar, which is the principal agent in the ſpontaneous motion of the fluid, is not preſent in ſufficient quantity; but if we ſupply it by an addition, we obtain a real wine, though a tart one, for the acid which predominates in this juice leaves us no room to expect any other.

In

In this wine, for example, and all others of the ſame kind, it appears that the original acid has not been changed, at leaſt not perceptibly, by the fermentation; ſo that, if the quantity of citric acid contained in it before its fermentation were aſcertained, we might probably find it entire in the wine; whilſt it is alſo very probable that the gummy and extractive particles would either not be found again in the wine, or only in a very inferior proportion.

Now if, inſtead of ſtopping the ſpirituous fermentation of the juice of the currant, we ſhould carry it on without delay to the acid fermentation, I have no doubt but that we ſhould obtain a currant-vinegar, the mucous and extractive principles of which would not be more ſuſceptible of any farther alteration than thoſe which enter into the compoſition of all vinegars, which, I believe, very well ſupport the heat of the equinoctial line. According to theſe ideas, it would be proper to prepare the lemon-juice for fermentation, by the addition of a ſmall quantity of ſugar, to carry this fermention to its maximum of aſceſcence, and to ſubject this acetified juice to chemical analyſis; and who can ſay whether the citric acid might not be found to exiſt entire after the fermentation, as is the caſe with the tartar? and whether, after it has been deprived at leaſt of the greater part of thoſe principles which have above been ſhewn to be obſtacles to its cryſtallization, we might not be able to complete its purification, either by means of concentration alone, or by the acid of a little ſpirit of wine? It would be neceſſary that theſe kind of experiments ſhould be repeated in a hot cli-

mate,

mate, and rather upon a large ſcale, in order to obtain more determinate reſults than thoſe which I obtained at Caſtille.

As the cryſtallized citric acid poſſeſſes a high degree of acidity, I thought it worth while to compare lemonade made with theſe cryſtals with lemonade made in the ordinary manner with the freſh juice of lemon. The lemon-juice was firſt tried, and it was found that the quantity required for making a large glaſs full, well ſweetened with ſugar, amounted to 8–9 drachms.

We have ſeen above, that an ounce of the juice that was uſed in the foregoing experiments contained about 34 grains of citric acid, beſides a ſmall proportion of malic acid. A ſimilar glaſs of lemonade was therefore made with the ſame quantity of ſugar as the firſt, and 34 grains of citric acid. The lemonade proved to be ſuch, that none of the perſons who were called to compare them could find any difference between the two, excepting that the latter had a ſomewhat more agreeable flavour. At firſt we could not diſcover the cauſe of this difference; but each of the perſons preſent having taſted them ſeveral times, it was agreed that the firſt lemonade had a ſlight degree of tartneſs, which was not perceived in that prepared with the citric acid.

This difference has juſtly been attributed to the ſmall quantity of the aſtringent principle of the lemon-juice. In fact, by adding a few drops of a ſolution of iron to the freſh juice of lemon, and afterwards ſaturating them with potaſh, we give it that vinous colour which is obſerved in old lemon-juice.

It is undoubtedly to this aſtringent principle of the lemon that we are to attribute thoſe griping pains,

pains, which are frequently felt in the bowels after drinking lemonade.

I shall conclude this memoir by describing the method of preventing an accident, which may occur in making experiments upon the citric acid.

If we have employed more sulphuric acid than was required for saturating the base of the citrate, this acid, when concentrated by the evaporation, will react upon the citric acid, and even separate from it some of its carbonic particles; and the mixture, becoming blacker and blacker, will refuse to yield any crystals. This excess of sulphuric acid may be remedied, by throwing a small quantity of chalk into the mixture, when heated, and afterwards filtrating it, in order to separate the sulphate of lime thus formed. With a little practice, we may easily learn to determine the point at which the sulphuric acid is almost saturated, in order that we may not neutralize the citric acid also.

See Dizé's Memoir on this subject in our twelfth volume.

XLVI. *List of Patents for Inventions, &c.*

(Continued from Page 216.)

ANTHONY BOWDEN, of Mellor, Derbyshire, Cotton Carder and Rover; for an engine or machine for batting or beating and cleaning cotton. Dated July 1, 1801.

JAMES MANLEY, of the township of Welton, in the parish of Great Budworth, in the county palatine

palatine of Chester; for improvements in the manufacturing of salt. Dated July 1, 1801.

George Medhurst, of Pentonville, Middlesex, Mathematical Instrument-maker; for improvements of certain machines for washing and wringing of linen, woollen, wool, cotton, silk, velvet, or any other commodity that requires washing, cleansing, or scouring. Dated July 10, 1801.

John Wilkes, of Sheffield, Yorkshire, Gunsmith; for a method of making self acting cylindrical spring snuffers upon a new construction, which cut off, confine, and extinguish, the snuff at one motion. Dated July 10, 1801.

Charles Earl Stanhope; for a new method of burning chalk, marble, and lime-stone, into lime. Dated July 20, 1801.

William Hoard, of Deptford, Kent, Ship-chandler; for an improved portable machine for manufacturing ropes and cordage, of any length, in a short space of ground, peculiarly adapted for shipping. Dated July 20, 1801.

Archibald Earl of Dundonald; for a new method or methods of preparing a substitute or substitutes for gum-senegal, and other gums, extensively employed in certain branches of manufacture. Dated July 31, 1801.

Mark Brocone, late of New Town, Ireland, but now of Cooper's-court, Tower-Hill, London, Esquire; for an instrument or engine possessing a power to work engines or machines, whether on water or land, or for other purposes to which the said can be applied. Dated July 31, 1801.

Printed by Nichols and Son, Red-Lion-Passage, Fleet-Street, London.

REPERTORY OF ARTS AND MANUFACTURES.

NUMBER LXXXIX.

Printed by NICHOLS and SON, Red-Lion-Paſſage, Fleet-Street, London.

XLVII. *Specification of the Patent granted to Mr.* JAMES MANLEY, *of the Townſhip of Witton, in the Pariſh of Great Budworth, in the County Palatine of Cheſter, Joiner and Engineer; for various Improvements in the Proceſs of Manufacturing Salt.* Dated July 1, 1801.

WITH A PLATE.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with the ſaid proviſo, I the ſaid James Manley do hereby deſcribe and aſcertain the nature of my ſaid invention, and the manner in which the ſame is to be performed, as hereinafter mentioned, and in order the better to explain the nature of my invention, I think it neceſſary to premiſe the following obſervations:

Every kind of brine which is uſed for ſalt-making contains in ſolution a quantity of earth, of earthy ſalts, and often of iron, all of which are

liable to mix with the ſalt during the evaporation of the brine, and to injure its purity unleſs they are removed. Some of theſe impurities may be ſeparated from the brine by the mere application of heat, but others are more difficult of ſeparation. In the method of ſalt-making commonly practiſed, the whole proceſs of boiling, of purifying, and of evaporating the brine, is performed in a ſingle iron pan, heated by furnaces placed beneath it. To purify the rough brine, the method uſually followed is to heat it for a certain time ſo as to ſeparate part of the earthy and metallic impurities, and likewiſe to continue the evaporation till a certain quantity of ſalt is made, and afterwards both to ſcum off from the ſurface, and to clear or rake out from the bottom, the earthy and metallic impurities as often as is judged to be neceſſary. Theſe clearings, which contain a large proportion of ſalt, are thrown away.

In the above-mentioned method of preparing the brine, a great quantity of fuel is conſumed in bringing it to the requiſite heat, and alſo much labour is often required in raking out the clearings, and alſo a certain quantity of good ſalt is loſt therewith, and likewiſe the brine is ſo imperfectly freed from its earthy contents, that a large portion of them ſtill remain, which during the evaporation either mix with the ſalt, rendering it leſs pure, or elſe form a hard earthy cruſt on the bottom and ſides of the pan, which requires to be often removed by the operation of *picking*, to the great detriment of the pan itſelf.

To remove and leſſen theſe inconveniences, and others which will be afterwards ſpecified, and to improve the quality of the manufactured article, I have invented and adopted the following appa-

ratus,

ratus, and processes, which constitute the several distinct heads of improvement of which my invention consists.

1st, My first head of improvement consists in adding to the common apparatus for salt-making another pan which I call a heating cistern, or preparing-pan. This is placed contiguous to the common salting-pan, and is heated by an extension of the flues from the said salting-pan, and therefore without requiring any additional fuel. The preparing-pan may be made of iron, or any other suitable material, and of a form the best adapted to different salt-works, and either with or without a cover. It should hold at least as much brine as will serve for one charge of the salting-pan.

The construction of the pans will be explained by a reference to the drawing hereto annexed or subjoined. (See Plate XIV.) Fig. 1, is the ground plan of a salting-pan, of the usual form, with a preparing-pan adjoining to it. *a. a. a. a.* is the salting-pan; *b. b. b. b.* the preparing-pan; *c. c. c. c.* flues which convey the flame from beneath the salting-pan to the preparing-pan; *d.* the chimney; *e.* a damper; *f. f. f. f.* fire-doors; *g. g. g. g.* grates. The arrows shew the course of the fires through the flues.

These pans may be used in the following manner: (allowing for such variations as may be found advisable from occasional differences in the quality of the brine, or the particular convenience of the manufacturer.) The rough brine in the state in which it is pumped out from the well, or drawn from the reservoir, is to be sent directly to the preparing-pan, instead of going at once into the salting-pan, which is done in the present

method of manufacture. The rough brine is then heated in the preparing-pan, by means of the ſame fire which is heating the brine already in the ſalting-pan. The rough brine by being thus heated in the preparing-pan, is brought without expence of fuel, to the degree of heat requiſite for depoſiting the earthy and metallic impurities ſeparable from it by mere heat. Theſe impurities ſubſide to the bottom, leaving the brine above them clear and hot, ready to be afterwards evaporated in the ſalting-pan before uſed, as ſoon as this pan is able to receive it, or in any contiguous ſalting-pan. The clarified brine may be drawn off from the ſediment by a ſyphon, or by any other ſuitable method; after which the ſediment is to be let off through a waſte-pipe at the bottom of the preparing-pan, and the whole well waſhed out. The preparing-pan is then to be filled with freſh brine, and heated as before, by the ſame fire which is ſupplying the ſalting-pan, ſo as to prepare a change of clear and hot brine for a ſubſequent evaporation.

The improvement in the proceſs of ſalt-making, which I have here ſpecified, will ſave a conſiderable quantity of fuel, inaſmuch as the brine may be brought in the preparing-pan, without any additional expence of fuel, to the ſame ſtate, for which in the uſual mode of manufacture a fire muſt be kept up for ſeveral hours under the ſalting-pan.

The above improvement will likewiſe ſave much of the time neceſſary to the proceſs of evaporation, as well as much of the time and labour now employed in clearing out the ſediment, and it will contribute to leſſen the quantity of the pickings, and conſequently the frequency of their removal.

2d, My

2d, My ſecond head of improvement in the manufacture of ſalt, which is quite diſtinct from the firſt, is to add to the brine a certain quantity of fixed alkali, eſpecially of barilla, or any other ſpecies of the mineral alkali, whereby ſeveral of the earthy ſalts contained in the brine and not ſeparable from it by mere heat are decompoſed, and the earth precipitated in the form of a ſediment, which may be removed without much difficulty. The quantity of the alkali, and the time at which it ſhould be added, muſt depend on the degree of concentration of the brine, and eſpecially on the nature and proportion of its contents, and as theſe differ much in different ſprings, and even in the water of the ſame ſpring at different times, they muſt therefore be left to the manufacturer to determine for himſelf according to circumſtances.

3d, My third head of improvement in the manufacture of ſalt, which is quite diſtinct from the two former, conſiſts of a peculiar method of conſtructing the flues for conveying the flame and heated air of the furnaces beneath the pans, ſo as to leſſen the requiſite conſumption of fuel. Many attempts have been made at various times to increaſe or retain the heat under ſalt-pans by means of circuitous, angular, or otherwiſe lengthened flues, all of which attempts have been fruſtrated by the heaving or riſing of the pan, when the liquor which it contains is fully boiling, which has allowed the flame to paſs directly over the croſs and midfeather walls to the chimneys, inſtead of circulating through the flues.

To remedy this inconvenience let flue-plates be formed of plates of iron bent to an angle lengthwiſe, in order to afford a face or flanch

part,

part, to be rivetted, or otherwife faftened to the bottom of the boiler, whilft the other part of the width of the plates project downwards from the bottom of the pan, and is either to be received loofely in a groove of the crofs and midfeather walls, or elfe to hang down for fome inches befide them. By this method the flame and heated air will be kept within the flues, notwithftanding the rife and fall of the pan, and the advantage in faving fuel which is derived from the circuitous courfe of the flues will be fecured.

Figure 2, exhibits one of the methods of applying thefe plates. *a. a. a. a.* is the falt-pan; *b. b. b.* grates; *c. c. c.* flues; *d.* the chimney; *e. e. e.* dampers; *f. f. f.* fire-doors. The dark lines reprefent the iron plates, and the lighter parts on each fide reprefent the brick partition walls of fupport, between which the plates are received loofely. The arrows fhew the courfe of the fires through the flues.

The above conftruction may be applied both to falt-pans and to pans of any defcription which are intended to bear the fire. In witnefs whereof, &c.

We are authorifed to inform the publick, that the above patent has been affigned to Meffrs. Swinton, Bleafe, and Co. Salt-manufacturers, near Northwich, Chefhire; and we have been defired to infert the following

REMARKS.

When we confider how much our knowledge of chemiftry, and of the various arts dependent up-

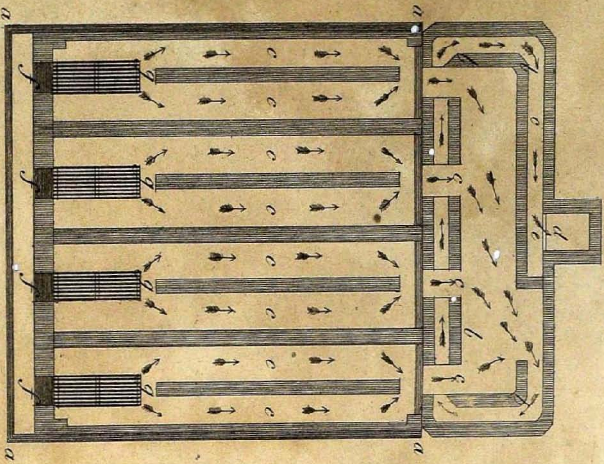


Fig 1.

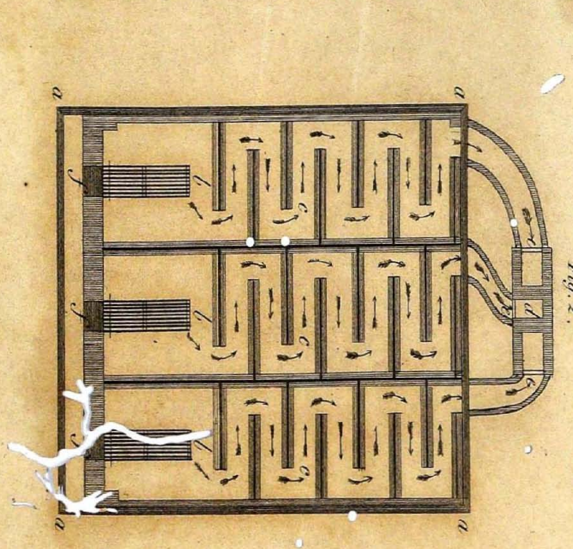


Fig. 2.

upon it, has been of late years increased, it appears extraordinary that the manufacture of Salt, which is so entirely a chemical process, should have been so little improved; and that, with little variation, the processes, which were adopted more than a century ago, should continue to be followed.

The attempts which have, at different times, been made to improve this manufacture, have had for their object either the œconomizing of fuel, or the production of a salt of increased strength and purity. The former object has been endeavoured to be obtained principally by variations in the construction of the flues by which the heat was conveyed under the evaporating pans; the latter by a more gradual evaporation of the water of the brine; in order to form a salt possessing the qualities of *bay-salt*, which is produced by a very slow evaporation. With this view a process was some years ago instituted at the salt-works at Howden Docks, in Northumberland, for applying steam to the bottom of the granulating pans; but it was on trial found so complicated, and it occasioned such a considerable consumption of fuel, that it was, after some time, discontinued. In an ingenious paper of Mr. Headrick's, of Glasgow, presented to the Highland Society of Scotland, in the year 1790, and which obtained the prize medal from that Society, the same idea was encouraged; and it was proposed to produce a slow and regular crystallization of the salt, either by a water-bath, or by the application of steam to the bottom of the pans in which the salt was granulated. Here again the expence of fuel was not sufficiently considered.

confidered. The object of the prefent patentee is to combine œconomy in fuel and time; and at the fame time to enable the manufacturer to produce a falt poffeffing a fuperior degree of purity, and more completely freed from all the earthy contents of the brine. It is a fact well known to chemifts, that if carbonate of lime has an increafed quantity of carbonic acid added to it, it is rendered foluble in water. Lime, thus fuperfaturated with carbonic acid, exifts in greater or lefs proportion in all brines. By the application of a moderate degree of heat, from 100° to 120° of Fahrenheit, a portion of the carbonic acid quits the lime, which, being thus rendered no longer foluble in water, is feparated. Where it exifts in fmaller quantity in the brine, it is never removed; but is left in the pan and mixed with the falt, which is afterwards formed: when in larger quantity, part of it forms a fcum on the furface of the brine, part fubfides to the bottom of the veffel in which it is contained. In the ufual mode of manufacturing falt, in which the whole procefs of granulation is carried on in one pan, notwithftanding the pains taken to fcum this carbonate of lime from the furface of the brine, or rake it from the bottom of the pan, a good deal muft ftill be left in the pan, and muft mix with the falt as it granulates, thereby confiderably leffening its purity. The apparatus of the prefent patentee obviates this evil, while it at the fame time faves, all the fuel and time required by the old procefs to effect the feparation of the carbonate of lime, all the labour employed in *clearing-out*, as it is called, and all the falt which is neceffarily raked out with the clearings. If the brine, as it very

very frequently does, contains also any carbonate of iron, the acid is here expelled at the same degree of heat, as from the supersaturated carbonate of lime; the oxyd of iron subsides to the bottom of the pan; and the brown or yellow tinge, which the presence of a very small proportion of iron gives to a large quantity of salt, is avoided.

A further advantage derived from this plan, is, that by the evaporation which takes place in the refining pan, a portion (probably a considerable one) of the sulphate of lime, contained in all brines, must subside in this pan, which is readily washed out with the carbonate of lime, and oxyd of iron: consequently a large part of that hard earthy crust, which constantly forms in the bottom of the pans, called by the workmen *pan-scratch* or *pickings* is prevented from being deposited on the bottom of the granulating pan. The process of the patentee for effecting these different objects by means of his preparing-pan, which is considered by far the most important part of his invention, has been found completely to succeed. He not only avoids the necessity of clearing out the earthy and metallic matter, which in the old process was deposited in the pan, in which the salt was granulated; but he is enabled to make in a pan of the same size one sixth more salt, and that too of superior quality, in the same space of time; while he has a saving o one fourth of the fuel formerly expended.

XLVIII. *Specification of the Patent granted to* JAMES ANDERSON, *of Mounie, in the Shire of Aberdeen, Doctor of Laws, for a Method of œconomizing Fuel in the heating of Houses, and for improving the Construction of Hot-houses by a new Application of known Principles.*

Dated February 10, 1801.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said James Anderson do hereby declare that my said invention is described in manner following; that is to say: let the heated smoke, as it issues from the fire, be conducted into a chamber that will be most commodiously situated beneath the floor of the house or apartment intended to be heated; extending the whole of its length and width, if it can conveniently be done, leaving only a vacuity between the inner side of the wall of the house and the wall of the smoke-chamber, all round, of two feet or thereabouts; no precise nicety as to its dimensions being requisite; the chamber for the smoke may be of any form or dimensions so as to suit the situation, and from two to six feet or more in depth, as circumstances will admit (the deeper always the better); and the roof of it ought to be below the level of the floor of the house or apartment intended to be heated, so as to leave a vacuity there of one foot, at least, in depth, and if two feet or more, so much the better. The roof and sides of this smoke-chamber should be made air-tight, and may be constructed of plates of metal, or any other matter that is capable of bearing

ing heat, and of eaſily tranſmitting it, and of being made air-tight. The grate where the fuel is to be conſumed ought to be placed lower than the floor of this chamber, if it can conveniently be done, (but this is not indiſpenſably neceſſary), and the chimney leading from the fire ought to riſe upwards within the ſmoke-chamber till it reach within about one foot of its roof, where it ſhould be diſcontinued and left open, having a ſpark-ſtone or cover laid over it to ſpread the heat. The chimney for carrying the ſmoke from this chamber, and for making the fire burn, ſhould communicate with the chamber near the floor or bottom of that chamber, and in no other place, unleſs occaſionally for particular purpoſes, by an opening formed into it immediately below the roof of the ſmoke-chamber, which is ſhut, in general, by means of a valve that can be opened at pleaſure. This chimney may either riſe directly to the height of the building, without interruption, or it may be made to open into a ſucceſſion of chambers of a ſimilar conſtruction to the ſmoke-chamber juſt deſcribed, as far as reſpects the tranſmiſſion of the ſmoke, though they may be varied in all other reſpects to ſuit the circumſtances of the caſe *ad infinitum*; that is to ſay: theſe chambers may vary in ſize, ſhape, and proportions; in poſition, being either above or below, or upon the ſame level with the original chamber, and ſo on. But although the beſt poſition for the ſmoke-chamber be directly beneath the building to be heated, yet, ſhould obſtructions prevent this, it may be placed without it, or under ſome other building, as near the building that is to be heated as may be.

 Connected

Connected with the original ſmoke-chamber, there may be formed another of an auxiliary ſort, which ſhould alſo be air-tight in the roof and ſides. This auxiliary ſmoke-chamber ſhould communicate with the firſt by means of two pipes, that can be cloſed or opened at pleaſure; one placed immediately above the floor, and the other next the roof of the principal ſmoke-chamber; and it ſhould alſo communicate with the open air by another opening or pipe iſſuing from the bottom of that auxiliary chamber. This laſt pipe ought to have a valve to ſtop or open at pleaſure, and ſhould always be cloſed when the fire is burning, and opened whenever it is extinguiſhed, the lower opening into the principal ſmoke-chamber being cloſed at the ſame inſtant that the other is opened; and if there be no auxiliary ſmoke-chamber, an opening of this ſort muſt be made into the principal ſmoke-chamber. Either at the top, or in any other convenient part of the chimney, ſhould be fitted a valve or ſtopper, which admits of being opened, or perfectly cloſed, at pleaſure. When cloſed, it will ſtop circulation, and ſoon extinguiſh the fire. Whenever it is cloſed, the air-hole of the furnace (if the heat be not required for another chamber) ought alſo to be cloſed, and the fire will then be inſtantly extinguiſhed; and the chamber being full of heated ſmoke will gradually tranſmit that heat through its cover and ſides to the air-chamber which ſurrounds it—the hotteſt part of the air thus heated will riſe to the top. As the heat in the ſmoke-chamber gradually abates, it will, of courſe, contract in bulk; and, by thus forming a kind of vacuum, muſt then draw in a ſupply of air from the

the auxiliary ſmoke-chamber to ſupply that want. As the higher opening into that chamber alone is now open, it muſt draw in now only the hotteſt part of the air, while the air from without is drawn into the bottom part of the auxiliary chamber; and as it will continue to occupy the loweſt place, no cool air can be drawn in, until the whole of the heated air ſhall be exhauſted.

The vacuity immediately above and around the principal ſmoke-chamber is intended for an air-chamber; the floor above which, and its ſides all over, muſt be impervious to air or water, and may be formed of flooring tiles or ſtone, or any other material proper for ſuch caſes that can be got cheapeſt at the place. From this air-chamber let a pipe or pipes paſs into the apartment intended to be heated, that can be opened or cloſed at pleaſure, and that can admit at pleaſure alſo of being opened either immediately below the floor, or at any greater depth, ſo as to allow air, more or leſs heated, as ſhall beſt ſuit the purpoſe, to paſs into the apartment intended to be heated. This heated air may (when thus admitted) be either allowed to ſpread in the apartment immediately above the floor, ſo as to heat the whole of the apartment; or it may be conveyed nearly to the roof before it is let looſe, ſo that the upper part of the apartment may be heated to a great degree without affecting the lower part of it, if it ſhould be ſo required.

Connected with the air-chamber may alſo be an auxiliary air-chamber, capable of retaining the heated air; between which two chambers, there ſhould likewiſe be a communication by means of a pipe; and this auxiliary air-chamber ſhould

ſhould alſo communicate with the common air by an opening juſt above the floor of it in the loweſt place, and no where elſe. The pipe that communicates between the air-chamber and its auxiliary, ſhould be ſo made as that the end of it which enters into the principal chamber, ſhould be placed juſt above the floor, and the other end of it ſhould open into the auxiliary-chamber high up, very near the upper part of it, and ſhould never be cloſed. In conſequence of this arrangement, when the air in the principal chamber, or heated air, comes to be heated, if the pipe communicating with the apartment above be kept ſhut, then as the air expands in conſequence of the heat acting on it from the ſmoke-chamber below, the coldeſt part of the air in that air-chamber will be forced to paſs into the auxiliary air-chamber, which, in its turn, will force ſome from thence into the open air. In this way, after the cold air is all diſcharged from the principal air-chamber, ſome part of the heated air will be driven into the auxiliary air-chamber, in which, aſſuming the higheſt place, it will there be retained, forcing the colder air below to paſs out into the atmoſphere. This proceſs muſt be continued as long as the air in the internal air-chamber continues to augment in heat, but when a portion of that heated air is let off into the apartment above, or when the fire is ſlackened ſo as to communicate no more heat to it, then in that caſe a ſuction will be made from the inner chamber ſo as to draw in air from the auxiliary air-chamber; but as the pipe opens into the higher part of the chamber, it will draw back only the hotteſt part of the air in it, and ſo on it will continue to draw back the ſuperfluous air ſo as to

derive

derive the whole benefit of it without any waſte whatever. But although this auxiliary air-chamber will be of great utility, it may, nevertheleſs, be diſpenſed with if the owner ſo chuſes; but the opening into the air-chamber below is indiſpenſable.

If the apartment placed above, and communicating with the principal chamber of heated air, be intended to be employed as a hot-houſe, its walls ought to be made of glaſs all round, if circumſtances will admit of it, on the north as well as towards all other points of the compaſs; thus to obtain not only the benefit of the ſun's heat to the fulleſt extent, but alſo to obtain as much light as poſſible, which is of the utmoſt utility to plants of all kinds, as, without it, they cannot be preſerved in good health. The whole ſhould be made air-tight. The under part of each of the front glaſſes ſhould be ſo formed as to admit of being opened, or to ſhut quite cloſe at pleaſure.

A row of windows, or air-holes, that admit of being opened at pleaſure, ſhould be placed along the North, or other ſides, towards the top, with this ſingle variation, that they ſhould be made to open alternately from below, riſing upwards, or from above falling downward, but ſo as always to admit of being ſhut ſo cloſe as to be air-tight. Theſe openings are to ſerve the purpoſe of emitting the air at pleaſure, and aſſiſting in ventilating the houſe. The edges of the door ſhould be alſo ſo made as to ſhut quite cloſe.

For the purpoſe of a pinery, or vinery, or peach-houſe, and moſt other uſes to which a hot-houſe is uſually applied, the roof of the apartment (in other words the hot-houſe) ſhould be placed in

a hori-

a horizontal poſition, or nearly ſo, ſomething like the ceiling of an ordinary apartment, only that that cieling ſhould be made of glaſs inſtead of plaſter, and ſhould be fixed to the joiſts above, and made altogether air-tight. The vines or other fruits intended to be forced may be extended cloſe under the glaſs. The bed in the ſtove ſhould be raiſed ſo high as to be as near the roof-glaſſes as the leaves of the plants in it will permit. Pipes of different lengths, which may be opened or ſhut at pleaſure, ought to be paſſed through the upper part of the hot-houſe for the purpoſe of letting off the heated air to that degree which ſhall be deemed eligible at the time, and ſhould reach to that depth in the houſe that ſhall be thought proper, for the purpoſe of regulating the heat of the ſtove, and keeping up an equality of temperature at all times without any attendance from the gardener. The ſtove being firſt made air-tight every where, let a pipe be placed in the floor, communicating directly with the chamber of heated air below; and let the top of that pipe be cloſed by means of a light valve that opens upwards. Let another pipe be placed above, that may communicate with the open air, if judged proper, having a light valve upon its upper end opening upwards alſo. Let an opening be then made into the ſtove near the floor, ſo as to admit a free communication by that means with the open air; lift up then the valve of the bottom pipe, the heated air will riſe upwards through it into the ſtove, gradually filling it; while the cool air that was in the chamber is imperceptibly driven off through the opening below into the atmoſphere.

When

When the stove has gradually acquired the degree of heat required (say ninety degrees of Fahrenheit's thermometer), shut the opening below, and all others, quite close. The hot-house being now air-tight, it must follow, that if more heated air arises from below, it will tend to expand the air already in the hot-house; in other words, to raise the temperature above ninety degrees. But in consequence of that expansive effort from within, an effort will be felt to close the lower valve (as is felt in a bellows when the two handles are pressed together), so that no more heated air can find access by that means. The same expansive effort will have a necessary tendency to open the upper valve, and thus heated air will be allowed to escape until the air in the chamber has come into an equilibrium with that of the atmosphere; or, in other words, till it be at ninety degrees, at which temperature alone it ever can, as thus regulated, attain that equilibrium.

If, however, from the coldness of the night-air, or from any other cause, the heat of the stove should be diminished, so as to fall below ninety degrees, the bulk of the air in it will be at the same time contracted, and a kind of vacuum be experienced. In that case, in consequence of the suction inwards, the upper valve would be firmly closed, so that no cold air can be there admitted; and, from the same cause, the lower valve will be opened so as to admit heated air again from below. In this way, as soon as the temperature shall attain the ninetieth degree, or such other regulated degree of heat as shall have been fixed upon, the lower valve would be closed, and thus an equal temperature would be kept up within the house at all times, whatever variations might take place in the

 atmosphere,

atmoſphere, without the attendance of any perſon whatever. If care be taken to keep up the heat in the air-chamber above ninety, or the regulated degrees, and provided the apartment above it (the ſtove) be perfectly air-tight, the variation of heat that could prove hurtful to the tendereſt plant could never be experienced.

In the vinery, peach-houſe, and others that require nearly a ſimilar temperature, where the ſun becomes the principal, if not the ſole ſource of heat, an auxiliary chamber ought alſo to be provided for receiving the heated air when there is an exceſs of it, and reſtoring it back again during the night-time, when the cold or other circumſtances render the contraction within ſenſible. This auxiliary chamber ſhould be conſtructed exactly in the ſame manner with thoſe already deſcribed. In this caſe alſo, as in the former, though the pipe of communication opens alſo into the auxiliary chamber near its roof, it ought to be made to iſſue from the hot-houſe itſelf, either higher or lower at pleaſure, which may be effected by fitting upon its orifice pipes of different lengths. As it may be convenient to rear vines entirely on the outſide of the houſe, proper openings ought to be provided for introducing the vines from without, and for withdrawing them at pleaſure. Theſe openings may be made either immediately under the roof of glaſs, or occaſionally juſt above the floor of the hot-houſe, as ſhall ſuit the inclination of the owner. They ſhould conſiſt of horizontal ſlits of a length and depth ſufficient to admit of the ſhoots being paſſed through them with eaſe, and admit of being cloſed either with a caſe with glaſs in it, or a wooden frame, the openings between the ſhoots being cloſed

cloſed up with ſoft moſs, cloſe rammed, ſo as to be air-tight, or with a plaſter of grafting loam, or any other ſoft material that is fit to prevent the paſſage of the air without too much cramping the ſhoot.

Peaches and cherries, which require the influence of the open air in the winter, may be raiſed in large tubs or boxes that admit of being removed; and if the ſtems be trained perpendicularly, nearly as high as the horizontal roof glaſs, and then bended over and trained horizontally, they may be admitted into the houſe, or withdrawn from it through horizontal ſlits ſimilar to thoſe above deſcribed, which admit of being cloſed in the ſame manner.

For the purpoſe of forwarding lettuce, or other low-growing plants in winter, or ſtrawberries early in the ſpring, let a ſet of frames be provided, conſiſting of open ſpars ſtrong enough to ſupport the weight that is to be put upon them; each of theſe frames ſhould be of ſuch dimenſions as to hold three rows of pots of the uſual ſize for that purpoſe, and of a length the whole width of the houſe, wanting two feet or thereabouts. A ſet of pans or boxes, made of any light material that can hold water, and having edges turned up one inch, ſhould be provided to be laid on theſe frames, and into theſe pans or boxes the pots ſhould be placed. Theſe frames may be ſuſpended from the ceiling or roof of the chamber by means of cords paſſed over pullies, ſo as to admit of being raiſed or lowered into a warmer or cooler region of the chamber at pleaſure. The plants may be ſupplied with moiſture by pouring water into the pans without lowering them, and the fruit may be ſeen, without moving them, through the glaſs above.

 Hitherto

Hitherto it has been the practice to have no hot-houſes of more than one ſtage or ſtory in height, but upon the preſent plan, in ſituations where they can be ſecured from effects of wind, nothing is to prevent them from being of two or more ſtages or ſtories; and where this can be ſafely done, it will prove a conſiderable ſaving on account of the roof. In that caſe, all the difference that will occur between the firſt and higher ſtages is, that the floor of theſe laſt, as well as the roof, will be of glaſs. A foot-path of wood or grating for the gardener ſhould be always, in that caſe, formed along the inſide of the north wall, having a ſlight rail on the inſide, of about three feet high, like the rough tree of a ſhip, or otherwiſe, to guard againſt accidents; and a looſe deal ought alſo to be provided to be ſhoved along to the top of the joiſts, when wanted, as a platform for the neceſſary purpoſes. Over the higheſt ſtage or ſtory muſt be thrown a roof, the ſouth ſide of which, and the eaſt and weſt ends, may be made of glaſs, and the north ſide either of glaſs or proper opake materials. This may be ſo conſtructed as to be employed for the purpoſe of a vinery, and at the ſame time of a reſervoir-chamber for heated air, which may be freed from its ſuperfluous heat, when that becomes too great, by means of a tube from the top, which admits of being opened or cloſed at pleaſure.

With a view to obviate the bad effects that might occaſionally reſult from too great a degree of heat in the higher regions of the hot-houſe, continued too long through accidental inadvertence in the gardener, the following apparatus may be uſed. Take a bladder, or other flexible bag, that is impervious to air, turn the mouth of it, while it is

open,

open, upwards, and heat it then to a considerable degree before a fire, or otherwise; when it has been made to attain a degree of heat higher than that of the hot-house, tie the neck close while it is not yet fully distended, though nearly so, taking care previously to fix a string to the bottom of it, by tying in a part of it, or otherwise. Then attach it to some fixed object; afterwards bring the house to a proper degree of temperature, and while it is in that state fasten the string that proceeds from the bag tight to some other object, the consequence must be, that when the heat augments the bag will become more distended, and, consequently, will augment in diameter, and contract in length, so as to tighten the cords, and when the heat abates it will become more flaccid, and of course slacken the cords, so that this may be employed as a moving power to open or close a valve as it contracts or dilates; and it will necessarily regulate the heat of the house by its spontaneous movements, without requiring attention from any one.

For the purpose of agitating the air in the house at pleasure, without the necessity of introducing air from without, and for many other indispensable purposes, the following apparatus has been contrived:—Make a cylindrical box of a construction similar to that of a drum; pass through it length-wise an axle, carrying arms of thin wood, or other light and firm material, to act, when put in motion, as a fan. This axle is to be properly supported at each end, and in such manner as to leave an opening at one or both of the ends for the purpose of admitting air to the fan. The fan may be moved by means of a simple handle, or, if greater velocity is wished,

by

by a large wheel at one end, acting upon a pinion upon the end of the axle, or by a large ſheeve acting upon a ſmall one, connected together by a band, belt, or chain. On one ſide of the cylindrical part of the drum leave an opening for the paſſage of the air when the fan is in motion, to which can be fitted at pleaſure a pipe that admits of movements, and of being occaſionally lengthened or ſhortened: it may be flexible or otherwiſe, as ſhall ſuit the circumſtances of the caſe, terminating in a ſmall nozzle to admit of its being directed to any point where it may be wanted. Let the mouth of another pipe, ſimilar to the above, be ſo formed as to cover the end, opening, or openings of the drum, for the ſupply of air, ſo that all the air that can paſs into the drum muſt firſt paſs through this pipe: by means of this apparatus, the air can be ſucked up by the machine from any part, either within or without the houſe, and ſpouted out into any other part of it, with a greater or leſs degree of violence, as circumſtances ſhall render eligible. The machine itſelf may be driven either by the hand, like a common winnowing machine, or it may be driven by means of a vane, moveable by the wind, placed on ſome convenient part of the building: or by water, or ſteam, or horſes, or any other moving power, which circumſtances may render eligible. Or this kind of ventilator may be produced by means of a bellows, having pipes of the ſort above deſcribed, adapted to the nozzle and the under valve of the bellows.

With a view farther to œconomize fuel when that becomes neceſſary for the production of heat, care ſhould be taken to have the whole of the ſmoke that ariſes from the burning fuel conſumed.

To

To effect this, let a fire-place be constructed in the following manner: — Let this fire-place have two grates, so connected as to admit of communicating alternately with each other: each grate should have two air-holes opening into the cavity below the grate, being close every where else: one of these air-holes should communicate with the atmosphere directly in front of the grate, and the other with a passage below that goes directly from the one grate to the other. These two air-holes should admit of being opened or closed at pleasure, but so as they can never be both open at the same time unto the same grate; this may be conveniently effected by a shifting door, or valve, which, when it closes the one hole, must necessarily open the other. For the sake of distinctness, let one of these grates be called No. 1, and the other No. 2. When the fire is to be lighted, let the air-hole in front of the grate No. 1 be opened, and the other air-hole to that grate will of course be closed. The coals in No. 1 being then kindled, the smoke, as it issues from the fire, should be conducted at first right upwards for a small distance, and it should then bend in the same plane with the wall, so as to assume a horizontal position, and in a direction pointing towards the other grate No. 2. It should then bend downward, still in the same plane, and proceed in that direction until it comes into the passage that leads from the one grate to the other beneath the level of the grates respectively. As the opening from this passage into the grate No. 1 is at this time closed, the air-hole in front being open, the smoke must pass on towards the other grate, No. 2, whose air-hole in front being now closed, it can receive no air to keep alive the burning fuel but that which comes

through

through that paſſage; and as this air conveys along with it the whole of the ſmoke that came from the burning fuel in the grate No. 1, that ſmoke, in paſſing through the fire No. 2, will be inflamed and entirely conſumed, thus tending greatly to augment the heat. It being alwas underſtood that the fuel in the grate No. 2 is at this time in the ſtate of charred coal, having been kindled previouſly to that in No. 1. After paſſing through the grate No. 2, the heated air riſes at firſt through the chimney of No. 2, in a perpendicular direction, to the ſame height as that of No. 1. It then bends in a horizontal direction towards No. 1, in the ſame plane with the wall; from thence it bends backwards in a horizontal direction for a ſmall ſpace, and may be then carried off through a chimney in any other direction that convenience can ſuggeſt. But when the fuel, that had been put upon the grate No. 1, ſhall be ſo far conſumed as to emit little ſmoke, let the front air-hole of No. 2 be opened, and freſh fuel be put upon it, the other air-hole of that grate being neceſſarily cloſed when the front air-hole is opened. The ſmoke ariſing from thence will now paſs upwards as before, but, inſtead of going back into the chimney as before, a moveable door or valve there being ſhifted, that opening is then cloſed, and another opening made into the ſame chimney to receive the vapour ariſing from the fire No. 1. The ſmoke will then be obliged to paſs downwards, and ſhould be conducted in the ſame manner as that before deſcribed of No. 1, into the paſſage that communicates between the two grates, and thus be forced to go under the grate No. 1, (the air-hole leading from that paſſage to No. 1 having been previouſly opened by ſhutting the

the air hole in front,) where it muſt paſs through the fire and be inflamed, from whence it riſes up and paſſes off through the chimney, as that from No. 2 did before.

Obſerve that at the place where the ſmoke enters from above into the paſſage that leads between the two grates, there is a moveable valve, which is opened at the ſame time that the ſaid air-hole into the chimney on that ſide is ſhut; the ſaid valve, when it opens, thus cloſing the ſimilar opening belonging to the other grate. Thus may the two fires have freſh fuel put upon them alternately, and be interchangeably ſhifted as often as can be wanted, ſo as always to conſume the whole of the ſmoke. The form and ſituation of theſe chimneys, grates, and valves, may be varied at pleaſure, preſerving the principle of cauſing the unconſumed ſmoke to paſs through the fire that has ceaſed to ſmoke.

For the purpoſe of obtaining ſteam when wanted, let the upper part of the chimney above deſcribed, where it runs in a horizontal poſition between the two grates, be made of ſuch a width as ſhall be deemed convenient, and that upper ſurface ſhould conſiſt of the flat bottom of a pan; or a flat pan may be placed above any kind of grate. Let a chamber be made above that, whoſe tops and ſides are formed by a veſſel containing water flat above, but projecting downward all round to the depth of ſeveral feet, ſo that water ſhall ſurround the chamber on all ſides except at the bottom part, which is the pan. The edges of the water-chamber ſhould go an inch or two lower than the pan, being wider than it; and an opening ſhould be left below the edges of the water chamber. Within this chamber, and immediately over the pan, let

there be placed another veſſel containing water. The pan is to be uſed for boiling and evaporating water. It is to be ſupplied with water from this inner veſſel, in proportion as it is evaporated, by means of a ball cock or float, and that veſſel, in its turn, is to be in like manner ſupplied with water, as it is drawn off from the outer veſſel that ſurrounds the chamber; ſo that it will be always heated before it reaches the evaporating pan. The ſteam that is firſt raiſed will fill the chamber above deſcribed, where it will accumulate until that chamber be wholly filled, ſo as to make its eſcape below the bottom of the ſides, from whence it may be conveyed, by a proper conduit, into a houſe, when it is there wanted. A pipe ſhould alſo be taken through one of the ſides, cloſe below the upper part of what may be called the ceiling of the water-chamber, that admits of being opened at pleaſure, by means of which the whole of the ſteam can be let off when it ſhall be judged proper. But as it may often happen that ſteam will be wanted only in moderate quantities, and at particular times, ſo as to render it unneceſſary to continue the evaporation of water during the whole time that the fire burns; in that caſe, the following apparatus may be reſorted to. By means of a bellows formed for that purpoſe, or a forcing pump, throw in a ſmall ſhower of water from time to time into the dry bottom of the pan, properly guarded by tiles laid above the bottom, ſo as to cover it when fully heated, which will be inſtantly converted into ſteam: and, after a ſhort interval, another and another, until as much ſteam ſhall be generated as ſhall be wanted at that time, when the evaporation may be diſcontinued.

For

For the purpose of obtaining a moderate degree of heat occasionally, without being under the necessity of lighting a fire in the house, the following apparatus may be adopted.—Make a hollow cylinder of metal, or other matter that is capable of retaining smoke and transmitting heat, open at bottom, but close at top. This cylinder ought to be of considerable proportional depth, and of a size proportioned to the use intended by it. The sides of this cylinder may do for some purposes if only single; but, in general, it ought to be double, leaving an opening between the two cylinders all round of about an inch or more in the clear. These two cylinders should be joined close together at the bottom, and the outer cylinder should rise somewhat higher than the part that closes the inner cylinder above; round the top of the outer cylinder should be formed a horizontal rim, of such a breadth as to admit of being depressed into a circular groove all around it, for the purpose of receiving a perpendicular rim running round the lower part of the cover, like that of the lid of a tea-pot. The cover itself may be made of such shape and dimensions as shall best suit the purposes intended at the time. Let the cylinder thus prepared, be heated to the degree wanted, by an Argand's lamp placed within it, which, instead of a glass tube to receive the flame, has one made of metal fitted to it, which is of such a length as to reach from the lower edges of the cylinder till within half an inch of the top of the inner cylinder; or it may be heated by suspending it over a good fire, upon a crow or otherwise, until it be sufficiently warmed, when it may be carried into the place where it is wanted, and there suffer to stand till it communicates heat

 to

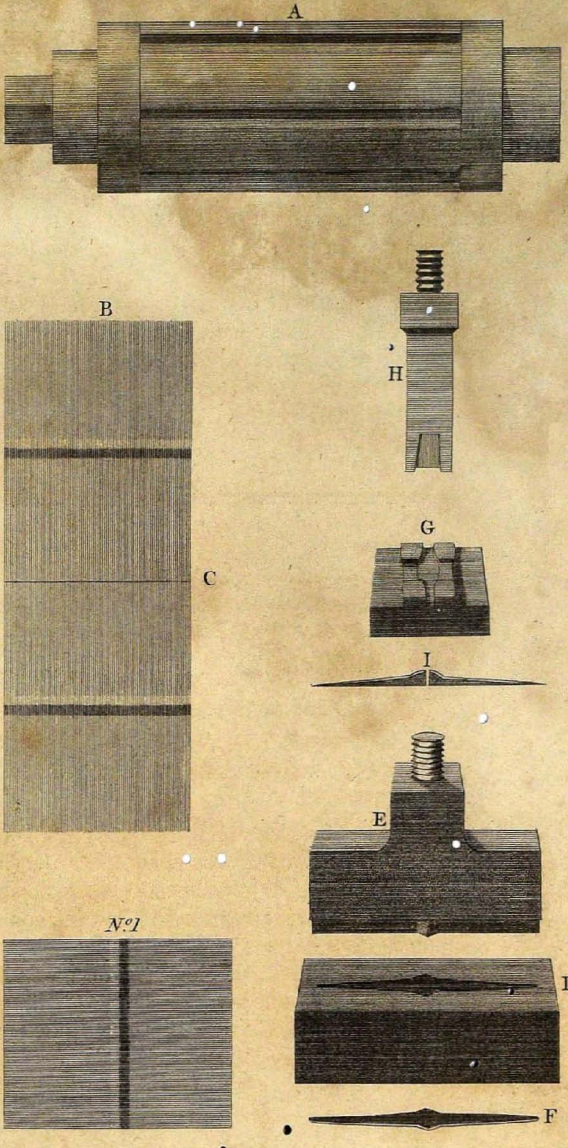
to the ſurrounding bodies. If water be put into the upper cavity above the top of the inner cylinder, the cover being at the ſame time taken off, ſteam in ſmall quantities may be raiſed in the houſe where a greater degree of heat is wanted; and, for long continuance, this apparatus may be made of very large dimenſions, and of any form that may beſt ſuit, and fixed in its place. The ſides may be made of bricks, or other ſolid ſubſtances, and a culinary fire adopted inſtead of the lamp, ſo that its power may be thus augmented to ſuch a degree as to anſwer many important purpoſes. It witneſs whereof, &c.

XLIX. *Specification of the Patent granted to Mr.* JOHN SPENCER, *of the Pariſh of Duffield, in the County of Derby, Nailmaker; for his new Method of making Horſe-ſhoe Nails.*

Dated June 20, 1801.

WITH A PLATE.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with the ſaid proviſo, he the ſaid John Spencer doth hereby declare, that his ſaid invention of a new method of making horſe-ſhoe nails is particularly deſcribed and aſcertained by the drawings hereon delineated or hereunto annexed, and by the references thereunto, and deſcription hereinafter contained; that is to ſay, (ſee Plate XV.): A, is the roll,


A
B
C
H
G
I
E
D
F
N.o1

roll, with impreſſions cut, or may be formed in caſting, and which muſt be varied according to the length of nails intended to be made, and to be run (in forming the iron for the nails) againſt a plain roll; after the iron has paſſed theſe rolls, it will be left according to B, which is then taken and ſeparated by ſhears or any other engine for the purpoſe of cutting at C, which is the thinneſt part, the edges of which are, if neceſſary, thinned by hand or tilt-hammer; the piece, No. 1, is then applied to the bed D, and punch E, which are fixed in a ſcrew-preſs, or any other power fit for the purpoſe, and when the ſtroke is made preſſes the iron out as F, which is then applied to the bed G, and ſeparater H, in a power ſimilar to that uſed for the bed and punch D, E, and which then leaves two complete horſe-ſhoe nails I. The punch E, may be formed of different ſhapes ſo as to ſuit any fancy, and it may alſo be formed to punch out only one nail inſtead of two if found more convenient. There may be rolls uſed for the purpoſe of making impreſſions on iron or other metal, and there may be punches uſed for preſſing out articles of different ſorts; if there are not, he the ſaid John Spencer claims every advantage to be derived from ſuch invention; but for the method of making horſe-ſhoe nails by this proceſs, he ſolely claims every invention and advantage. In witneſs whereof, &c.

L. *Specification of the Patent granted to Mr.* Edward Walker, *of Rathbone Place, in the Parish of Saint Mary-le-bone, in the County of Middlesex, Vintner; for a Portable Stove, or Kitchen, for the Purpose of dressing and cooking Victuals.*

Dated May 12, 1801.

WITH A PLATE.

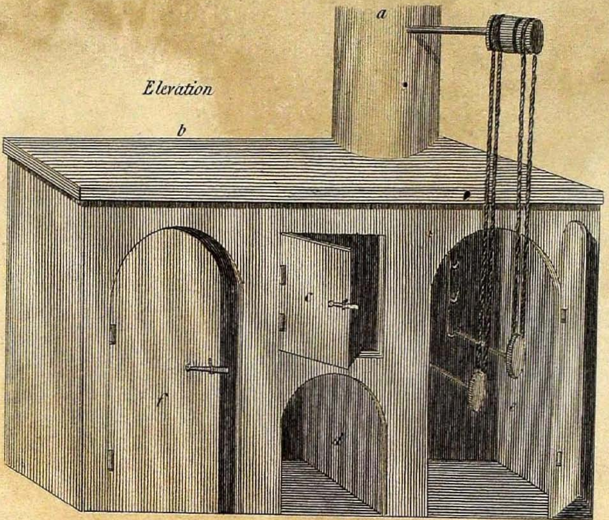
To all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, I the said Edward Walker do hereby describe and ascertain the nature of my said invention, and the manner in which the same is to be performed, by the plan drawn in the margin of these presents, (see Plate XVI,) and as follows; that is to say: the whole to be made of cast or wrought iron with fire-place in the centre, inclosed with a door, ash-hole under, a closet on each side, one of which will serve for the purpose of baking, &c. the other to contain two spits, racks, &c. complete, the top to be used for the purpose of a broiling plate heated by the same fire, the smoke conveyed through an iron funnel in which is fixed a smoke-jack to turn the spits. In witness whereof, &c.

Reference to the Plate.

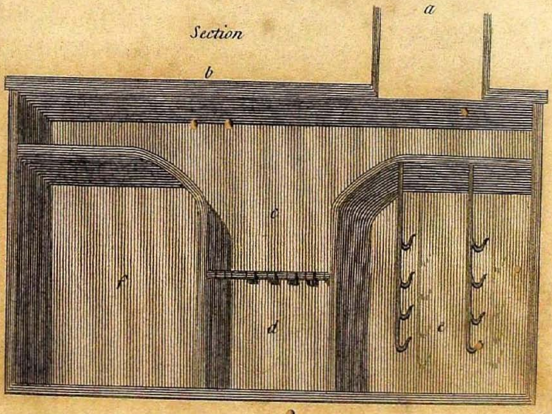
a, funnel for smoke; *b*, top which can be used as a boiling plate; *c*, place for fire; *d*, ash-hole; *e*, closet to roast meat in or broil; *f*, hot closet or oven.

LI.

Elevation



Section



LI. *Account of some Experiments made with a View to ascertain the relative mechanical Effects of the human Body labouring in various Postures. By* Mr. Robertson Buchanan, *Engineer. Communicated by the Author, in a Letter to the Editors.*

A FEW years since I had occasion to make some experiments with a view to ascertain the relative mechanical effects of the human body working in different postures. Those experiments were made with the most simple and least expensive machinery I could contrive, and the results were sufficiently accurate for my purpose. I offer them to you, thinking they might perhaps be of some use until something better on the subject may be published. I am &c.

Robertson Buchanan.

75, *Piccadilly, August* 18, 1801.

First. Turning a winch—the rope and the person's hand being at the same distance from the centre of motion.

Time, 9 seconds; height, the weight was raised 17 feet; weight, 16 pounds; friction of the machine equal to 12 pounds; total resistance, 28 pounds. $28 \times 17 = 476$ the effect.

Second. Rowing posture.

Time, 9 seconds; strokes, $3\frac{1}{2}$; length of stroke, 2 feet 2 inches; weight, 90 pounds; space passed in 9 seconds, 7 feet 7 inches; friction, 8 pounds. Total resistance, 98 pounds. $98 \times 7{,}7 = 682\frac{1}{3}$ the effect.

Third.

Third. Common mode of working a pump.

Time, 9 seconds; strokes, 4; weight, 70 pounds; length of stroke, 1 foot 1 inch; space passed in 9 seconds, 4 feet 4 inches; weight of brake, 3 pounds more than was necessary to overcome the friction, therefore 3—70=67 pounds 67 × 4.4 feet=290⅓ the effect.

Fourth. Bell ringing posture.

Time, 9 seconds; strokes, 3; length of stroke, 3 feet; weight, 70 pounds; space passed in 9 seconds, 9 feet; friction, 2 pounds; total resistance 72 × 9 feet=648 the effect.

Recapitulation.

		Effect.
Turning a winch	. . . . . .	=476
Rowing posture	. . . . . .	=682⅓
Common mode of pumping	.	=290⅓
Bell ringing	. . . .	=648

It may be observed, that the time occupied in these experiments was very short, notwithstanding which the effect of the rowing posture is greatest. Had more time been occupied, the advantage of the rowing posture would have been much more evident; it being known, from the experience of ages, that there is perhaps no posture in which a man can work so long without fatigue. On the other hand, the disadvantage of the common mode of working a pump would also have been more strikingly apparent; it being known, from long experience likewise, in that posture men are able to make short exertions only. That the bell-ringing posture is very effective may be conceived by seeing the effects produced by coal-heavers, who work somewhat on that principle.

LII.

LII. *A short Sketch of the Drainage and Improvement of a Marsh, near Marazion, in Cornwall; describing a peculiar Mode of taking off the Water, and securing the Land from the Overflowing of the Sea.* By Mr. RICHARD MOYLE, *of Marazion.*

From the COMMUNICATIONS to the BOARD of AGRICULTURE.

A PIECE of land called the marsh, or bog, near Marazion, in Cornwall, containing thirty-six statute acres, has, from time immemorial, been covered with two or three feet of water, and which, at spring-tides, was overflowed with the sea, by means of a river which passed through the land. This ground looks towards the south, and is separated from the sea by a long skirting of sand of about seventeen acres, over which the turnpike road passes towards Penzance, on its most elevated part: on the north of the marsh lies some croft ground *, which gradually rises as it retires from the bog, so that the marsh is surrounded on the north and south by elevated spots; and the water on its surface usually crept away to the sea by means of a river, through which the water at high spring tides always had access. From the depressed situation of this marsh, it was impossible to take off all the surface water through the river, and recourse was had, for this purpose, to a square wooden pipe of nine inches diameter, which was introduced at that part of the shore called half-ebb, and which was eight feet lower

* Croft ground is higher spots not subject to inundations.

 than

than the surface of the marsh. This pipe was introduced through the sandy soil, in some places twenty-four feet deep, till it arrived to the south part of the bog, where it was found to be six feet under the surface. At this place a reservoir of eighteen feet square, and eight feet deep, was immediately cut out; and the water draining from the marsh, during the time the tide was in, was received in the reservoir, and discharged when the tide was out, through the pipe with great velocity. The sea, at high water, covers this pipe with nine or ten feet of water: a long trench, of three feet deep and five wide, was extended from this place, east and west, on the south side of the bog, for its whole length, bordering on the sandy soil; and at the distance of every sixty yards, a similar trench was cut up directly north towards the croft, which divided the whole marsh into oblong square fields. By the means of these trenches, or open drains, the whole surface water was conveyed directly to the reservoir, and thence to the sea. The pipe at both its extremities was guarded with valves, which shut at the approach of the tide; and during its flowing, the water accumulated about two, or two and a half feet high in the reservoir; and as the sea retires, the collected water runs off without any interruption, till the next return of the tide: the pipe is covered with the sea six hours in every twelve. This singular mode of drainage answers uncommonly well, and has never once failed in five years: the extremities of the pipe have also iron bars placed before them, to prevent the intrusion of extraneous bodies. As soon as the surface water was removed, a strong embankment of turf was made on the south and east sides, to prevent the overflowing

flowing of the tides; and the water, which formerly diffused itself over the whole of this ground, was collected into a river, and carried to the sea on the outside of this embankment. In cutting the open drains, a pot of copper coins, containing about a thousand, was discovered three feet under the surface, and which appeared to belong to the Emperor Victorinus, who reigned in the third century. These coins were much injured by the corrosion of the salt water; but several were still perfect enough to trace the outlines of the Emperor. As soon as the evaporation had assisted the consolidation of the surface, the air, within a mile of the marsh, became so strongly impregnated with a sulphureous swell, as to render the place quite obnoxious to passengers.

On examining the different strata, we found that two feet and a half of the surface consisted of mud and a peaty substance, most strongly interwoven with the roots of goss (*arundo phragmites*) and common rushes, which were the only substance that grew spontaneously on its surface; below this, was a stratum of three feet and a half of pure peat, of a very inflammable nature, and which seems to have extended over twenty acres of the marsh: under the peat lay a bed of sand, from four to six feet deep; from which we may conjecture that the whole was formerly an arm of the sea, and that the dropping of vegetables, and deposition of mud, (which possibly formed the peat,) had gradually expelled the sea; except at spring tides. This stratum of sand does not appear to be the original bed of the sea; for, on streaming for tin, another floor from six to ten feet deeper was discovered, consisting of round smooth pebbles, and gravelly substances, con-

taining tin; among which were willow trees and hazel nuts, in the most perfect state.

Mode of Improvement.

The surface was pared and burned; and after repeated ploughings, &c. for two years, large bodies of clay, with manure, were then carried on its surface, and a slight crop of white oats with ever-grass (ray), common and Dutch clover, sown in the spring. The saltness of this ground was so very powerful for the first three years, as to destroy every crop; on the fourth, the land began to vegetate partially; but on the fifth, or present year, 1798, every part seems to be quite alive; so that every kind of vegetable now flourishes with great luxuriancy. It has afforded this summer very good crops of hay, and an abundant and rich pasture, with a prospect of improvement the next season. The expences of draining this ground, with trenching, paring, ploughing, burning, and manuring it, with the failure of three years' crops, amount to a very considerable sum; and this distressing circumstance is increased, on its being only a leasehold for three lives.

The sandy land has been partly inclosed, and covered with large bodies of clay and manure; it has afforded remarkably fine crops of turnips, and the grass of this season has been very luxuriant. The crofty land on the north (twenty-two acres) has been all cultivated, first with potatoes, and afterwards sown with wheat, barley, oats, and turnips, and produced very good crops.

The

The whole of this improved ground has been productive of conſiderable advantages to the public, particularly to the poor. Four hundred perſons yearly receive turf from it; two hundred and fifty are fed moſt plentifully with potatoes, which are planted here by very poor people, who are, in conſequence of having land given them, become uncommonly induſtrious; and the whole neighbourhood, by its drainage, have got rid of low nervous fevers and agues, with which it was continually peſtered.

The whole ground under improvement conſiſts of ſeventy-five acres, of which thirty-ſix are marſh, twenty-two croft, and ſeventeen of ſand. In 1798, forty acres were under different crops; *viz.* wheat two acres and a half, barley nine, oats eight, turnips two, potatoes five, hay and paſture thirteen and a half.

On the ſides of every open trench is planted a row of quickſets, interſperſed with a few planes and pineaſters. Theſe are defended from the cattle and blights by means of a temporary turf hedge, and promiſe to afford a pleaſing diviſion of the land in a few years. To every incloſure of the marſh a part of the riſing ground of the croft is annexed to accommodate cattle in wet ſeaſons.

In the year 1798 *this land was viſited and examined on the ſpot as to the facts, by Sir John Call, and the above particulars given him by the proprietor.*

LIII.

LIII. *Account of an Embankment against the Sea.* *By Mr.* ANTHONY TATLOW.

From the COMMUNICATIONS to the BOARD of AGRICULTURE.

THE embankment againſt the ſea, that I mentioned when laſt at the Muſeum, is upon the eſtate of the Earl of Aſhburnham, at Pembrey, in the county of Carmarthen, whither his lordſhip ſent me upon his coal and other buſineſs, and with directions to ſee if I could deviſe any method of preventing the ſea from making further incroachment upon his property, which it had been doing for many years; and particularly in October 1795, had broke in and covered many hundred acres, damaged the houſes, buildings, ſtack-yards, and gardens; and it was the general opinion, that a regular embankment muſt be formed, which would coſt ſome thouſand pounds, he having ſeveral miles of coaſt. The view that I firſt took was upon a very windy day, and the ſhore an entire ſand which extended at low water many miles. In riding along, I perceived that any piece of wood, or accidental impediment to the courſe of the ſand, raiſed a hill: it immediately occurred to me, that by making a hedge at the weak and low places, with wings to catch the ſand as the wind blew it in different directions, I ſhould obtain the deſired effect. I therefore directed ſtakes nine feet long to be cut, and drove one foot and a half into the ſand, at two feet and half diſtance from each other; betwixt which I had furze interwove, ſo as to form a regular furze hedge

hedge seven feet and a half high. Of this, since last June, I have done eleven hundred and thirty-seven yards; and in October last when I was there, a great deal of the hedge was covered, and since that time I am informed by letter, that a great deal more of it is so; and that the neighbouring inhabitants draw great comfort to themselves, from the security my furze embankment gives them, as its present appearance plainly evinces, that at a trifling expence I can secure Lord Ashburnham's estate from being inundated; for, whenever the first hedge is not high enough to prevent the sea overflowing, another may be built upon the sand formed by that hedge, and so on in succession, till it is perfectly safe *.

LIV. *Description of a Kettle for boiling Inflammable Fluids. By Mr.* THOMAS P. SMITH.

WITH A PLATE.

From the TRANSACTIONS of the AMERICAN PHILOSOPHICAL SOCIETY.

WHEN we consider the many unhappy accidents that occur from vessels containing inflammable fluids boiling over and setting fire to the buildings in which manufactories of them are

* Sir Thomas Hyde Page had long ago executed similar embankments.

carried

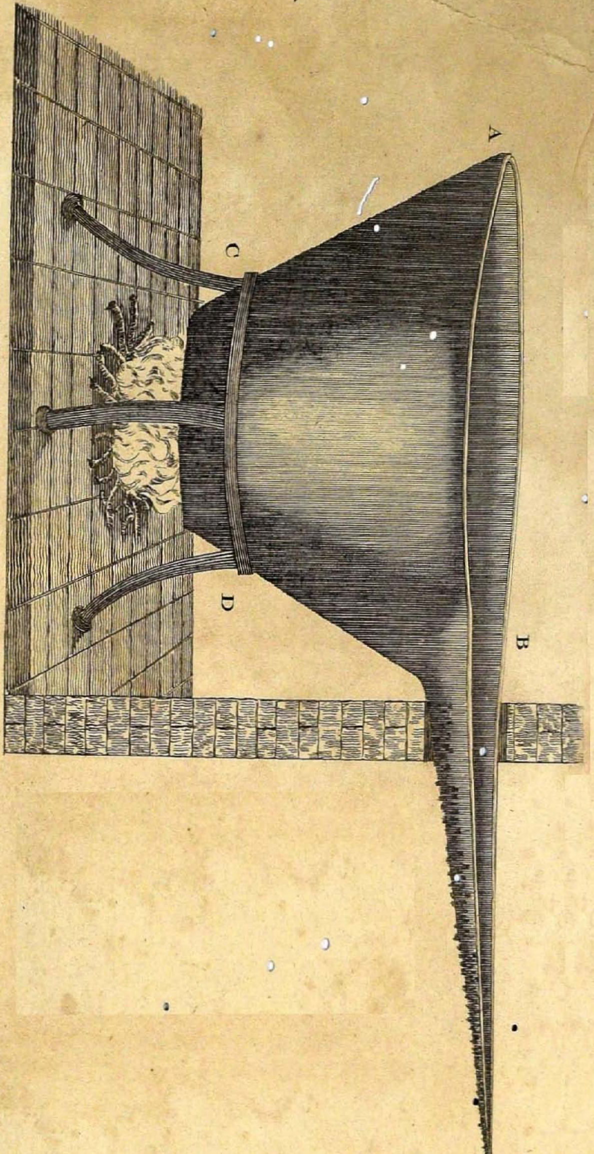
carried on, it muſt ſtrike us as a matter of importance to form a veſſel which ſhould be ſo conſtructed as to prevent any of thoſe accidents, and yet of ſo ſimple a form as to render it fit for general uſe. Impreſſed with theſe ideas, I take the liberty of offering for your approbation the following plan.

Let A B C D (ſee Plate XVII.) repreſent a large kettle, B E, a ſpout running out to the diſtance of three or four feet, commencing at B, four or five inches from the brim of the kettle, and the termination of it E, juſt as high as the brim A. Let the bottom of this ſpout be covered with wet ſponges or rags. Now ſuppoſe the kettle to be filled up to B with any fluid, then as ſoon as it commenced boiling it would riſe in the kettle, and in riſing but a ſmall perpendicular height would paſs a conſiderable diſtance up the ſpout B E: here the liquor would ſoon cool, and of conſequence fall back into the kettle, and the whole ſubſide to its original height. This would occur as often as the fluid roſe above B, as the evaporation from the wet ſponges or rags would keep B E conſtantly cool.

It would perhaps be beſt to paſs the ſpout through the ſide of the building into the open air, as thereby the evaporation would be increaſed, and conſequently the ſpout kept at a lower temperature; in this caſe it might be covered.

In caſe of the fluid to be boiled poſſeſſing a very ſtrong elective attraction to caloric or the matter of heat, the ſpout might be extended to the width of the diameter of the kettle or a projecting ſhelf might be formed all round it, lined below with wet ſponges or rags.

In


A
B
C
D
E

In conformity to the wiſh of the ſociety I procured a veſſel of the form here propoſed. I firſt tried the experiment with water, it boiled very rapidly, but every time the water roſe into the ſpout it immediately ſubſided, although the ſpout had for ſome time been directly expoſed to the heat of one of Lewis's furnaces: I afterwards attempted it with oil, but before the oil boiled the ſoldering of the veſſel, which was made of tin, melted.

LV. *Experiments upon Magnetiſm. By the Rev.* James Madison, *Preſident of William and Mary College.*

From the Transactions of the American Philosophical Society.

In the review of my philoſophical courſe for this year, I have been led to make ſome experiments upon magnetiſm, which appeared to fall within the views of the American Philoſophical Society. It is for this reaſon that I have taken the liberty of communicating them to you.

Few ſubjects in natural philoſophy are, in reality, more intereſting to mankind than magnetiſm; and yet the inviſibility of the agent, and the conſequent difficulty of purſuing a cauſe, which ſeems to be ſubjected to none of our ſenſes, has greatly reſtricted the progreſs of knowledge in this branch of phyſics. Some phænomena, which have long attracted the attention

of the philoſopher, and excited the admiration of the vulgar, have received different ſolutions, grounded upon as many different hypotheſes. No method appears to have been adopted to ſhew the fallacy of the one, or the verity of the other. They ſtill remained as hypotheſes. The following experiments, ſimple as they are, give a ſolution, which carries with it ocular demonſtration; and, as the juſt explication of every fact is a real advance in philoſophy, I truſt they will not be thought unworthy of attention.

The phænomena to which I allude are thoſe, which magnets, placed upon paper, exhibit with filings of iron, when they are ſprinkled about them. Many ingenious men have ſuppoſed, that the arrangement of the filings clearly indicated the paſſage of a magnetic fluid or effluvia, in curved lines, from one pole to another of a different denomination; and hence have ſought for the ſolution of other phænomena upon a much more extended ſcale. Others, and particularly Cavallo, in his uſeful treatiſe on magnetiſm, from the action of the magnet upon the filings, rendering each particle itſelf a magnet. The proper ſolution ſprings from the following experiments:

Experiment I. Place an artificial magnet, of the uſual oblong form, and of ſufficient ſtrength, upon a diſh; let the ends be two or more inches diſtance from the edge or rim: cover the magnet with water about one-tenth of an inch. Then ſprinkle, or ſift the filings of iron through gauze, ſo that they may fall gently near the equator of the magnet. You will immediately ſee the filings to divide; one part moving with an accelerated velocity to the north pole, the other part to the ſouth pole, each approaching as near to its reſpective

ſpective pole as the interpoſing fluid will permit; each turning and preſenting a diſſimilar pole to that which firſt put the particle in motion. As other particles ſucceed in their turn, the ſame effects take place; each endeavours to approach as near to its pole, as its centre, as poſſible; but the particles already arrived preventing an approach within the limits thus previouſly occupied, the whole are neceſſarily arranged in the form of concentric circles. Particles of water in forming drops, or of mercury in forming globules, obey nearly the ſame law.

Thus doth this experiment unequivocally demonſtrate, from the motions of the floating particles, that attraction is the ſole cauſe of this phænomenon, and that this force is equally exerted by each pole. It ſhews, at the ſame time, that each of the filings, even the ſmalleſt, becomes itſelf a magnet ſo ſoon as it arrives within a ſhort diſtance of its attracting pole. This is particularly evinced by thoſe particles which are firſt put in motion, and which occupy the neareſt ſtations. For, immediately upon their arrival at a certain diſtance, they turn round, and preſent to the magnet their oppoſite extremity.

Experiment II. Place two diſſimilar ends of magnets about an inch apart, in a large diſh; let them be juſt covered with water; ſift the filings between the ends. The particles of iron are immediately attracted by the neareſt pole; they move quickly in oppoſite directions, occupy the neareſt ſtation they can, become themſelves magnetic, and preſent to each other diſſimilar poles. The particles attracted by the poles of the magnets thus mutually attract each other. Between the poles of the large magnets, the filings

are arranged in ſtraight lines; becauſe there they tend directly to the attracting points; the more removed, the more curvilineal their poſition; becauſe each particle making the ſame effort to occupy the neareſt ſtation to the centre of attraction, they are all neceſſarily forced into a poſition correſponding with that effort.

Experiment III. Place ſimilar ends of two magnets, as the diſſimilar were ſituated in the laſt experiment, and ſift the filings between them. Here alſo you ſee them to be acted upon by attraction as before; they move to the neareſt pole, become magnetic, and preſent to each other ſimilar poles; that is, ſuppoſing the north poles of two magnets to be oppoſed, all thoſe filings which are attracted by the north pole of one of the magnets preſent a north pole to the north pole of all thoſe attracted by the other magnet; they repel each other, of conſequence; a vacuity is obſerved between the reſpective parcels of filings; whilſt the appearance of reverted curves is exhibited, on account of the repulſion which their ſimilar poles exert upon each other.

Thus, beſides the proof which theſe experiments afford, that the attractive force of the magnets, at either pole, is the real cauſe of the phænomena which the filings exhibit, they prove alſo, in the moſt ſatisfactory manner, that the action of the magnet upon the filings, when they approach within a certain diſtance, renders them magnetic, and hence produces the effects mentioned in the two laſt experiments. But, in every inſtance, attraction firſt operates. Similar poles, whilſt they are repulſive of each other, are ſtill attractive of all other ſubſtances upon which the magnet acts. The ſame body, at the

the ſame time, appears to exert two oppoſite powers.

The cauſe of magnetic attraction and repulſion, as well as of all other attractions or repulſions, lies ſtill hid in the receſſes of nature; but the manner, in which theſe forces produce certain phænomena, is no longer concealed from us.

Theſe experiments may be agreeably varied by placing three or four magnets upon each other, then covering them only partially, and ſprinkling the filings on each ſide of them.

In every magnet there is at leaſt one line, called the equator, where the attractive power vaniſhes: from this line, towards either pole, it gradually increaſes, and hence thoſe filings which are near to the ſides of the magnet will incline towards them, forming angles, which appear to be ſuch as the reſolution of two forces, one lateral, the other polar, would neceſſarily produce.

Perhaps this method of making experiments, by ſubſtances floating in water, and thus ſubjected in all their motions to our examination, may lead to more important diſcoveries. The rates in which the magnetic attractive force decreaſes, at different diſtances, may, I think, be collected from noting the velocity with which the floating bodies move, at different diſtances from the poles, or the ſpaces, which they paſs over in equal times. Nothing obſtructs an accurate ſolution of this problem but the difficulty of obtaining meaſurements of ſufficiently ſmall intervals of time. If the experiment were made upon a large ſcale, the difficulty might be removed. The remarkable acceleration which is obſervable, when the filings come near to their attracting point, ſeems to ſatisfy the eye, that the attraction increaſes

creaſes in a greater ratio than according to any law yet aſſigned

One magnet acts upon another, at a conſiderable diſtance, either by repulſion or attraction. Will not theſe experiments lead to a rational conjecture, that in every inſtance the action is communicated by intervening magnetic ſubſtances? It acts through atmoſpheric air. But this air may, from its conſtituent principles, and it is ſaid does, contain iron The ſmall particles floating in the atmoſphere may be acted upon like thoſe floating upon water. The tenuity of the particles will only render the action more ſenſible. Each may become a magnet, and thus, by the action of all the intervening affected particles, the action of one magnet may be communicated to the poles of another diſtant magnet.

I have made an experiment, in order to aſcertain whether a magnet could exert its power in a Torricellian vacuum. A ſmall quantity of filings was poured into a glaſs tube, of ſufficient length; it was then filled with mercury, and inverted in the ſame fluid; the filings floated on the ſurface of the mercury in the upper end. The reſult was, that the action of the magnet upon the filings, at equal diſtances, was ſenſibly leſs than when the tube was full of atmoſpheric air. The want of a tube of ſufficient diameter prevented me from making the experiment in ſo ſatisfactory a manner as I wiſhed. It appears, however, worthy of being repeated by thoſe who may poſſeſs the neceſſary means. If the magnetic power ſhould be obſerved in ſuch a vacuum, then the above conjecture will merit and receive the fate which has generally attended all reaſoning in phyſics not founded on accurate experiment.

LV.

LVI. *On the Means of purifying infectious Air, &c. extracted from a Work of Citizen* GUYTON DE MORVEAU. *By Citizen* DEYEUX.

FROM THE *ANNALES DE CHIMIE.*

AMONGST the important discoveries which we owe to chemistry, those, undoubtedly, chiefly deserve our attention, which, at the same time that they present us with facts valuable in a scientific point of view, afford also results from which great advantages may accrue to society in general. It is then, chiefly, that the utility of chemistry ceases to be a problem, and that we are compelled to acknowledge the just title, which this science has to be ranked amongst those, the study of which ought most assiduously to be cultivated.

The work, of which I am about to give an extract, we owe to a distinguished man of learning, a profound chemist, who, having meditated for a long time upon various important phenomena, that had presented themselves to him under a multitude of circumstances, conceived that he might make use of the knowledge which he had acquired, in order to combat one of those scourges which desolate the human race, and against which all the art of medicine has hitherto proved insufficient.

Having once conceived this idea, he had a difficult task to accomplish. Citizen Guyton, however, has surmounted all the obstacles that stood in his way, and, by his courage, his patience, and perseverance, has obtained such satisfactory results, that he thought he ought no longer to withhold from the publick the fruits of his labours.

His

His work is divided into fix parts.

In the firft, the author gives an hiftorical fketch of the experiments which he made in the year 1773, with the muriatic acid employed in fumigations.

Already, at this period, he fays, attempts had been made to difinfect the air tainted by putrid miafmata; but, as all the fubftances that had been employed for this purpofe had not produced the effects that were expected from them, I imagined, after long reflection upon the fubject, that I ought to turn my attention to the muriatic acid; as the great expanfibility of its vapours led me to fufpect, that they might be proper for feizing upon the ammoniac, which I then fuppofed to accompany all the odorous putrid miafmata, and for compelling it to quit them, and leave them to fubfide by their own gravity.

It was neceffary to afcertain the powers of the remedy, which theory feemed to point out, by the teft of experiment: Citizen Guyton, therefore, availed himfelf of a circumftance, which he thought it the more neceffary for him to make ufe of, as it afforded him an opportunity of making an experiment upon a large fcale, and fuch as he ftood in need of, in order to obtain refults concerning the nature of which no doubt could remain.

In the courfe of the winter of 1773, the burying-vaults of the principal church at Dijon being found to be entirely full, it was ordered that they fhould be cleared. Some precautions that had been taken, with a view to prevent the exhalation of the putrid vapours, which, it was prefumed, muft arife during this operation, having proved unfuccefsful, the infection foon became

so insupportable, that it was necessary to abandon the church. In the mean time, the putrid effluvia diffused themselves among the neighbouring houses, and then gave rise to a contagious fever.

It was then that it was thought proper to consult Citizen Guyton, who, after having informed himself of all the precautions that had been used, proposed fumigations with muriatic acid.

His advice was adopted; and the effects were so speedy and decided, that, four days after, the church was re-opened, and all the ecclesiastical offices were re-established in it, without danger, and even without apprehension.

Similar fumigations were afterwards practised in the dungeons of the prisons of Dijon, in which a contagious fever had produced such terrible effects, that the greater part of the prisoners perished.

Though the infection was of the most virulent nature, it was at last so completely destroyed, that a student of surgery requested leave to sleep in one of the dungeons that had been disinfected.

Success so decided naturally produced a great deal of confidence in the remedy. We find, therefore, that when the *Conseil de Santé* & Vicq d'Azyr were consulted upon the means of stopping the progress of a contagion that had appeared in the military hospitals, and in the stables where a great number of cattle were kept, they did not hesitate to prescribe fumigations with muriatic acid, as the most certain remedy to which they could have recourse.

A circumstance, which certainly ought to excite surprise, is, that the persons, to whom the care of executing these fumigations was intrusted,

 neglected

neglected to give ſufficient publicity to reſults ſo ſatisfactory as thoſe which it is known they obtained.

This neglect, as Citizen Guyton very juſtly remarks, is the more unpardonable, as it has tended to retard the adoption of a proceſs, which, in many caſes, would have proved invaluable, as, by means of it, many thouſands of perſons might have eſcaped the effects of contagions, to which they have fallen ſacrifices, on account of the inſufficiency of the means that were employed againſt them.

The muriatic is not, it appears, the only acid which has been conſidered capable of depriving the air of its contagious quality. This we find from the account which the author gives, in the ſecond part of his treatiſe, of experiments made in foreign countries with fumigations of different mineral acids.

One of the oldeſt works relative to this ſubject, which fell into the hands of Citizen Guyton, is entitled *Rapport des Experiences faits en Angleterre, par Ordre de l'Admirauté, à Bord du Vaiſſeau d'Hôpital, l'Union.*

The Lords of the Admiralty having requeſted Dr. Smith to direct means for putting a ſtop to the contagion that had appeared on board the Union, he adviſed Mr. Menzies, ſurgeon to the navy, to try fumigations with nitric acid. Theſe fumigations were made with great care, and were attended with ſuch ſucceſs, that, from the day on which they were begun to be employed, the mortality ceaſed, and the greater part of the accidents occaſioned by the contagion diſappeared.

Some time after, the ſame means were employed for deſtroying the contagion on board of the Rat-

vessan, and the Revel frigate, in which a malignant fever had also broke out.

The success which Mr. Menzies obtained in these three instances left no doubt in his mind of the utility of the process which he had employed, and of the necessity of having recourse to it, whenever it should be necessary to purify the air of putrid miasmata.

The same opinion was also adopted by Dr. Smith; for he concludes the report, in which the above-mentioned facts are related, with saying, That the experiments of Mr. Menzies clearly establish two facts; in the first place, that the nitric acid has the power of destroying contagion; secondly, that it may be employed without producing troublesome effects upon the persons who respire it. He considers this discovery as being applicable to every kind of contagion, and even to that of the plague. Considered in this last point of view, he thinks it ought to interest every nation, &c.

Thus the beneficial effects of the nitric acid seem to be as decidedly established as those of the muriatic; however, as Mr. Menzies very properly observes, the use of the nitric acid is only exempt from inconvenience, as long as we are able to reduce it into vapour, without its being converted into nitrous acid; for, otherwise, it would occasion accidents, which it would be difficult to remedy.

Mr. Cruikshanks appears also to have employed acid fumigations; however, it is evident that he has given the preference to the oxygenated muriatic acid gas.

The process which he employs for obtaining it is very simple: it consists in mixing accurately two parts of common salt, and one part of the

 black

black oxyd of manganeſe. After having diluted this mixture with a ſmall quantity of water, concentrated ſulphuric acid is gradually added to it. Immediately a large extrication of vapours takes place, which unite with the putrid effluvia in ſuch a manner, that the air, in the place where the experiment is made, is ſoon found to be purified.

In Spain, the fumigations with ſimple muriatic acid, reduced to the ſtate of vapour, are generally adopted; and they are there conſidered to be ſo little capable of producing accidents, that they are performed even in chambers actually inhabited.

Finally, it appears, that ſimilar fumigations have frequently been practiſed in France, and that whenever they have been properly conducted, they have been attended with ſucceſs.

In the third part of his treatiſe, the author makes ſome reflections on the effects of acid fumigations, and examines the different opinions that have been advanced, in order to explain their mode of operation.

The principal problem to be reſolved in ſeeking the means of purifying a maſs of infected air, was to find out agents that poſſeſſed the power of deſtroying the contagious miaſmata, and particularly the putrid ſmell that always indicates their preſence. It has been ſhewn, in the two firſt parts of this work, that ſome of the mineral acids had produced this two-fold effect; but it was uſeful to inquire, whether theſe acids acted in the ſame manner, and whether the reſults which they preſented were equally ſatisfactory. It was neceſſary alſo to aſcertain, whether their operation ought to be attributed to oxygen; whether ammoniac formed an eſſential part of the putrid effluvia; whether

whether they were always accompanied with carbonic acid gas; and, finally, whether the vegetable acids might not be employed with advantage.

The solution of all these questions could not fail to throw a great deal of light upon the causes and immediate effects of contagion; the author, therefore, thought it an object that particularly demanded his attention. For this purpose, he instituted a course of experiments, both with a view to investigate the nature of the putrid miasmata, and to ascertain the mode of operation of the agents with which they are brought into contact.

The infected air upon which he performed his experiments, was obtained from slices of raw beef, which he had expressly placed in a situation to putrify. This air, which possessed all the properties that were required, had scarcely been mixed with lime-water, when it immediately appeared that this was decomposed. The same circumstance took place with the solutions of the nitrates of silver and mercury; but, notwithstanding this decomposition, the fetid smell continued to be perceived as before.

Slips of paper, stained with fernambourg, the petals of mallows, curcuma, and a solution of copper, were suspended in vessels filled with the putrid air. After having remained there for the space of twenty-four hours, the colours appeared somewhat fainter, but they had undergone no change that indicated the presence of ammoniac.

Several metallic oxyds, such as that of zinc, the black oxyd of manganese, the brown oxyd of lead, &c. having been left for several days in contact with the same putrid gas, exhibited no change

change of colour, and had produced no disengagement of ammoniac.

From the results of these, and several other similar experiments, the author draws the following inferences.

1. That air impregnated with putrid effluvia contains more carbonic acid than the ordinary air of the atmosphere.

2. That the effects of putrid air are entirely independent of the presence of carbonic acid; since, after the separation of this acid, the air still retains its putrid smell.

3. That putrid air does not contain ammoniac in a free state, as it does not change the colours of stained paper that is placed in it.

These points being ascertained, Citizen Guyton subjected a certain quantity of putrid air to the test of the eudiometer; not so much with a view to determine its degree of salubrity, as to ascertain in what proportion oxygen gas was contained in it.

The result of this second set of experiments soon proved, that the putrid air contained very nearly as much oxygen gas as the ordinary air of the atmosphere; and that, consequently, the deleterious effects of the putrid air ought not to be attributed to the deficiency of oxygen gas.

The nature of the effluvia that rendered the air fetid still remained to be investigated.

In order to obtain a perfect knowledge of their nature, one must have been able to analyse these effluvia; but, unfortunately, the chemical means were found inadequate to the purpose.

All that could be presumed was, that these putrid effluvia, being compound substances, must, like all other compound bodies, be susceptible

tible of decompofition, whenever we present to them agents, poffeffing greater affinity with one or more of their elements than thefe elements have with each other.

Here alfo experiments were neceffary, in order to afcertain in how far this idea might be founded.

We fhall foon fee how ufeful the refults of thofe which Citizen Guyton has inftituted for this purpofe have been to him, and what advantages he has derived from them, in order to fix once for all the opinions that ought to be adopted, with refpect to the choice of the means to be employed for difinfecting air vitiated by putrid miafmata.

Convinced that the atmofpherical air ought to be confidered as ferving merely as a vehicle to the putrid effluvia, the author brought fetid air into contact with various odorous vapours, fuch as are extricated during the combuftion of benzoin, aromatic plants, &c. He afterwards ftrongly agitated another quantity of thefe putrid effluvia with the folutions of myrrh, benzoin, and balfam of Peru in alcohol. The refult of all thefe trials was not fatisfactory, for the putrid fmell ftill continued to be perceptible.

The fame happened alfo with the pyro-ligneous acid.

Neither was the refult more favourable, when he tried the detonation of gunpowder, at feveral times, in large veffels filled with putrid air; he only remarked, in this cafe, that a difplacement of the mafs of infected air was produced, but its qualities were not corrected.

The refult was not the fame with the acetic acid; its action was fpeedy; for the putrid fmell very foon ceafed to be perceptible.

He alfo tried the fulphuric and fulphureous acid. The firft produced no change; the fecond was obferved

observed to have diminished the smell, but not to have removed it entirely.

Besides the experiments which I have quoted, the author has attempted a great many more, which I shall pass over, as they proved altogether abortive; but there are some upon which I shall dwell, on account of their importance; I mean those that were made with the nitric, the simple muriatic, and the oxygenated muriatic acids.

The greatest difficulty which Citizen Guyton had at first to surmount in this new kind of experiments, was to obtain the vapours of nitric acid free from nitrous gas; however, having at length, after a number of trials, obtained them such as he wanted, he immediately brought them into contact with the infected air. Upon afterwards examining this air, it did not appear to retain the smallest trace of a fetid odour.

In order to establish the inference by a comparison of the results in circumstances perfectly similar, he afterwards subjected the muriatic acid to precisely the same experiments. In this case also the fetid smell was completely destroyed.

Finally, the oxygenated muriatic acid acted in so decided a manner upon the putrid air, that from the moment when it was mixed with it, the putrid smell ceased to be perceptible.

When we reflect upon the experiments that have been recorded, it is easy to see, that, if their results have not all been equally satisfactory, they may at least serve to point out the agents in which we may place some confidence, and enable us to choose those whose power of destroying putridity appears the most decided.

The only means of determining our choice of such agents would, undoubtedly, be to compare the

the effects produced by the different agents that were employed in the abovementioned experiments.

Those produced by the use of perfumes, vinegar, the detonation of gunpowder, the pyro-ligneous acid, the sulphurous and sulphuric acids, &c. were, as has been seen, either none at all, or tardy, or of little efficacy. The acetic and nitric acids have appeared to act in a very decided manner; but the difficulty of obtaining them in that state, in which it is necessary they should be, in order to produce such favourable effects, is a considerable objection against their use.

The same is not the case with the simple muriatic acid; the facility with which it is reduced into vapour, the great expansibility of this gas, and, above all, the promptitude of its operation upon the putrid miasmata, shew of how great importance it is not to neglect its use.

However, adds the author, I have the satisfaction of announcing, that this is not yet the most powerful means with which the progress of chemistry has furnished us for resisting contagion. The oxygenated muriatic acid is, beyond all contradiction, the most certain specific, and the most ready preservative which we can employ against it.

It seems that, after having entered into the discussion of all the subjects in question, Citizen Guyton might have presented the publick with the general conclusion of his treatise: however, he thought it still incumbent upon him, to examine the influence which oxygen might exert of itself in the process of disinfection, and to inquire whether all kinds of contagious miasmata were equally subject to the operation of the same agents.

 Since

Since chemistry has made us acquainted with the particular nature and properties of oxygen, it was soon found that it possesses a great disposition to combine with various substances, and particularly animal matter. The constant observations that have been made upon this subject have led to the supposition, that oxygen might be employed as a medicine.

In fact, it is certain that medicines act only by inducing changes in the body, that tend to attenuate the morbid matter, and re-establish the order and regularity of the animal functions; it must also be allowed, that oxygen, as it possesses such properties, must be a real medicinal substance, and that, in order that it may act with efficacy, it is only necessary to employ it in a state of appropriation that may ensure its success.

This fact is at present so well demonstrated, that several physicians of the highest reputation are inclined to admit of only two species of medicines, namely, the *superoxygenating* and the *disoxygenating*; the action of which they explain by saying, that they *burn*, or *unburn* (*brûlent* ou *debrûlent*) the bodies with which they are brought into contact; meaning, that they furnish them with the oxygen which they want, or deprive them of that which they possess in too large a proportion.

The expression of *burning*, employed in order to account for the manner in which medicines operate, as forced as it may appear, will be acknowledged to be strictly just, when we consider that, besides the combustions that take place with rapidity and an extrication of heat, there are also others which go on slowly, but the effects of which are perfectly similar to those of the former.

Both

Both in the one and the other, it is always the oxygen which tends to combine itself; and which, according to its greater or less degree of affinity with the body with which it unites, entirely changes the form of this body, its weight, its taste, and its colour, and at last imparts to it properties which it did not possess before.

According to this explanation, it is easy to see that the alterations which animal substances incessantly undergo are, in fact, the effects of combustions, slow indeed, but which may, in some degree, be accelerated by presenting these same substances with a large quantity of oxygen at once, or placing them in contact with bodies, which, containing a large quantity of this principle, may easily yield to them a portion of it.

It was a similar theory, which led, almost naturally, to the medicinal use of oxygenated fats, nitric acid, oxygenated muriatic acid, the superoxygenated muriate of potash, and various other oxygenated substances, the sure effects of which afford the means of combating a variety of maladies, to the progress of which medicine had before no remedy to oppose, or could only cure with a great deal of difficulty.

Since, therefore, it is impossible to deny the power which oxygen incessantly exercises upon animal substances, it must also be admitted, that the putrid effluvia that exhale from these same substances must also be subject to the action of this agent, and that, by combining with it, they must necessarily acquire new properties.

In order to explain more at large his ideas with respect to this subject, the author has thought proper to treat of the oxygenating substances,

 and

and particularly the oxygenated muriatic acid, confidered only as prefervatives againft contagion.

It is a fact univerfally admitted, that among perfons the moft expofed to the influence of contagious maladies, there are fome upon whom they produce no bad effects. Great pains have been taken, and always in vain, to explain the caufe of fo fingular a circumftance. But, fays Citizen Guyton, what need is there to have recourfe to abftract theories, or even to inquire at all into the caufes of a change of properties that does not exift, when the refiftance, which fome perfons fhew towards the morbific matter, may be explained in a fimple and purely chemical manner, from its analogy with one of thofe general phænomena, which are daily exemplified before our eyes in an infinite variety of operations.

Let us take an example, he adds. We know with what facility the fulphuric acid attacks aluminous earth. This earth, however, is fufceptible of a ftate of aggregation, in which it refifts all combination, without there being the fmalleft ground to fufpect that it has undergone any alteration in its nature. Might it not alfo be the fame with the human body? and might we not affert that a certain ftate of health is connected with a ftate of aggregation, that refifts that combination of the contagious miafmata with the body, which would take place if the force of aggregation were different?

Moreover, this explanation feems to accord with facts, which various obfervations that are conftantly made have enabled us to collect. It is known that the beft means of guarding one's felf againft the impreffion of contagious miafmata, when we cannot remove ourfelves out of the infectious

fectious atmoſphere, is to ſupport, and even augment the vital powers: now as the oxygenating ſubſtances poſſeſs this property in the higheſt degree, it is evident what great advantage may reſult from their uſe, and how much thoſe eſpecially deſerve the preference, which, like the oxygenated muriatic acid, may eaſily be reduced into the ſtate of gas.

Carried thus, by reſpiration, into the naſal and pulmonary cavities, diſſeminated in the ambient atmoſphere, or introduced, by reſpiration, into the ſtomach, acting finally upon the whole ſurface of the body, they operate as a ſtimulant, which augments the activity of the organs, excites their ſenſibility, and ſoon puts a ſtop to the effects of the miaſmata, which, in general, act only by debilitating.

Under this point of view Citizen Guyton has conſidered the mode of operation of the oxygenating ſubſtances. This efficacy appeared to him to be ſo well demonſtrated by theory and experience, that he preſumes that thoſe who reflect upon the ſubject will no longer fear the appearance of contagion, as they will be ſure of having the means of guarding themſelves againſt it.

TO BE CONCLUDED IN OUR NEXT.

LVII.

LVII. *Obſervations concerning an Earth containing Magneſia, known by the Name of* Terre de Salinelle, *or* Terre de Sommières. *By* E. Berard, *Ex-profeſſor of Chemiſtry at the* Ecole de Medicine, *at Montpellier.*

FROM THE *ANNALES DE CHIMIE.*

THE manufacture of artificial alum, in the large way, and by proceſſes both ſimple and eaſily to put in practice, has for a long time been the object of my labours. For this purpoſe, I was obliged to look out for the argills that abounded moſt in the alumine, and that were the neareſt to the place in which the manufacture was carried on.

The earth of Salinelle, near Sommières, in the department of Le Gard, is reckoned one of the beſt kinds of argill for taking ſtains out of cloth; it is even generally known in the country by the name of Pierre de tache (fuller's earth); and this property induced me to examine it. I procured a certain quantity of it, upon which I immediately operated with a view to obtain alum. But what was my ſurpriſe, when in the firſt experiment, which was to impregnate it with ſulphuric acid (at 40 degrees of Baume's hydrometer), I perceived, 24 hours afterwards, a very conſiderable effloreſcence, and the ſmall maſs of the earth, that had been impregnated with the acid the day before, changed into a ſaline-earthy ſubſtance, full of ſmall ſhining cryſtals. I ſoon diſcovered, both by the taſte and the manner in which this firſt combination took place, that the ſalt

ſalt that had been formed was not alum. Some experiments which I made led me to imagine that it was ſulphate of magneſia. In order to aſcertain this point, I immediately went to Salinelle, to examine the place from whence this earth was procured, and I afterwards ſubjected it to the experiments of which I am ſhortly to give an account.

The village of Salinelle is ſituated at the diſtance of about two kilometres from Sommières, upon the road from this town to Quiſſac, and almoſt cloſe to the banks of the river called Le Vidourle. The whole village is built upon a ſoil under which this earth is generally found. A ſingle individual at preſent employs himſelf in digging it, and furniſhes it, as it is called for, to ſome merchants, factors, and druggiſts. The firſt of theſe conceal the uſe which their employers make of it, and it is ſuſpected at Salinelle that ſome ſoap-manufacturers make uſe of it in the preparation of this compound. The druggiſts prepare from it the ſubſtance which is known in pharmacy by the name of *Terra Sigillata.*

The ſtratum of the Terre de Salinelle is at the depth of about two metres and five decimetres from the ſurface of the ground: firſt we find ſix or ſeven decimetres of good vegetable earth; afterwards ſeveral cloſe ſtrata of white chalk, the whole about one metre five decimetres in thickneſs. In the middle of this thickneſs appears a vein of blackiſh ſemi-tranſparent ſilex, a decimetre and five centimetres thick. We afterwards meet with a ſmall layer of Terre de Salinelle, mixed with fragments of the ſuperior ſtrata, and at laſt we find the vein of good Terre de Salinelle,

two

two decimetres and five centimetres in thickneſs, under which we immediately meet again with a mixed ſtratum, and afterwards thoſe of white chalk that had before been found above. The diſpoſition of all theſe ſtrata may eaſily be obſerved in digging wells, vaults, or foundations; in theſe caſes the earth of which we are ſpeaking is carefully collected.

The Terre de Salinelle, when dug out of its bed, is ſtill ſoft, very moiſt, lamellated, and ſlightly tranſparent when divided into thin plates. It has a chocolate colour, nearly reſembling that of the ſmall roots of ſome trees that grow upon the ſame ſoil. This earth when dried in the air acquires a leſs deep colour; it becomes of a light grey, ſlightly tinged with red, and by being dried in this manner it loſes about thirty parts in a hundred of its weight. It then acquires hardneſs, produces a ſtrong ſenſation of aſtringency when applied to the tongue: it does not loſe its coheſion in the water, like the argills, but when moiſtened and kneaded it forms a paſte pretty ſoft and fine to the touch; placed upon red hot coals, it decrepitates and flies into ſplinters. In order to enable it to bear the action of the fire, I was obliged to pound it into a coarſe powder, and form it into balls, by moiſtening it with a little water; I then heated it to whiteneſs, without the ſmalleſt decrepitation taking place. By this operation 100 parts that had already been dried in the air were reduced to 68; the earth became very light, and of very beautiful white colour, much reſembling that of the magneſia prepared in the laboratories. If we calcine it in powder, the evaporation of the water produces a bubbling

bubbling even in this powder, which ceases as soon as the whole of the water is dissipated.

Acids poured upon this earth, after it has been dried in the air, produce no sensible effervescence; they combine with a portion of its constituent principles, and the products are magnesian salts.

1. Sulphuric acid, concentrated to 66°, becomes violently heated as soon as we mix it with this earth. When reduced to 40° it does not become heated immediately; but if we form a paste with this acid and the same earth in powder, a disengagement of heat takes place at the end of half an hour, the paste puffs up, increases greatly in its volume, and is at last reduced to a very light pulverulent substance, in which we may observe an infinite number of small crystals. The salt thus formed has all the characters of true sulphate of magnesia. A certain quantity of earth is left behind, which has resisted the action of the acid; this appeared to me to be silex.

2. The nitric and muriatic acids, poured upon this earth in sufficient quantity to form a paste, produce no disengagement of heat nor efflorescence; the paste on the contrary attracts moisture from the atmosphere, but nitrates and muriates of magnesia are formed. All these salts yield, by means of the alkalies, an abundant precipitate of very white, light, and pure magnesia.

I boiled at several times, and during several hours, the Terre de Salinelle, dried in the air and reduced to powder, in the three abovementioned acids, in the proportion of 100 parts of the earth to 600 of acid. I then lixiviated it with a large quantity of water and filtrated it: the earth that remained upon the filtre, calcined to

 rednefs,

redneſs, was reduced to 45 parts: this appeared to me to be ſilex; it is very white and fine.

The ſame acids exert a far inferior operation upon this earth, when it has been calcined to redneſs. The concentrated ſulphuric acid does not even produce any extrication of heat, and the earthy reſiduum is more conſiderable, though we take into the account the quantity of water that exiſts in the non-calcined earth.

All the lixivia produced by combinations of any of the three acids with this earth are but ſlightly coloured, eſpecially the muriatic, and they are hardly coloured at all when the earth has been calcined; however they all yield, with the pruſſiate of lime, a precipitate of iron in the ſtate of Pruſſian blue.

From the experiments which I have related, and from ſome others which it would be ſuperfluous to deſcribe, it appears, that 100 parts of the Terre de Salinelle, dried in the air, and ſuch as it is generally found ſome time after it has been dug out of the ground, form a natural mixture of 32 parts of water, 22 of pure magneſia, 45 of ſilex, and 1 of oxyd of iron; that this earth differs greatly from the magneſian mixtures known by the names of ſteatites, albeſtes, micas, &c.; and that it ſtands in the ſame relation to magneſia as the argills do to alumine; in a word, that it is a genuine ore of magneſia, which, as far as I know, has not been hitherto deſcribed; but for giving a very accurate and detailed analyſis of it, I neither poſſeſſed proper inſtruments, nor ſufficient chemical knowledge. I therefore reſolved to ſend a quantity of this ſubſtance to Citizen Vauquelin, whoſe profound genius for the art of chemical

chemical analysis is universally known, and who has engaged to ascertain the place in which this earth ought to be ranged in natural history and chemistry.

A pupil and associate of Citizen Chaptal, and engaged for a long time, by profession, in the application of chemistry to the arts, I endeavoured to apply the Terre de Salinelle to an useful purpose, and from the experiments which I have made upon a large scale, it appears, that 100 parts of this earth and 100 parts of sulphuric acid, at 40°, produce, by simple mixture, by the lixiviation of this mixture, by condensation of the lixivia and crystallization, 95 parts of beautiful sulphate of magnesia in fine silky crystals. The mother-waters, which have a yellow tinge imparted to them by a small quantity of sulphate of iron, may still contain 5 parts of sulphate of magnesia. This result presents the manufacturers of sulphuric acid with an advantageous method of preparing the sulphate of magnesia in the large way. Medicine will derive from it another advantage; namely, that of easily procuring this salt in a state of purity, as well as the common magnesia; for it is universally known that the sulphate of magnesia, or Epsom salt, such as is met with in commerce, and which is obtained from the water of salt marshes, is a mixture of various salts, such as sulphate of magnesia, sulphate of soda, muriate of magnesia, muriate of lime, &c.: it is also known that most druggists, by using the sulphate of magnesia of commerce, in order to extract the magnesia, obtain a mixture of this earth and lime. This mixture must necessarily produce effects very different

 from

from those that belong to pure magnesia or its carbonate; and we shall be sure of obtaining these two substances pure, if we employ the sulphate of magnesia prepared with sulphuric acid and the Terre de Salinelle.

I propose still to pursue my experiments, with a view to ascertain the farther uses to which this earth may be applied; but I have hastened to make it known, in order that other chemists may also make it an object of their attention, and that the public may the sooner be in possession of the advantages which they may derive from it.

LVIII. *Account of a Discovery made by Citizen* Leroux, *of a gummy Substance contained in the bulbous Root of the Plant termed* Hyacinthus non scriptus. *In a Letter from Citizen* Deyeux.

FROM THE *ANNALES DE CHIMIE.*

Citizen Leroux, druggist at Versailles, has communicated to me some accounts concerning the gum which he has succeeded in extracting from the bulb of the plant termed *Hyacinthus non scriptus*. As the processes which this artist employs, in order to obtain the product in question, appeared to me to deserve being made known to the public, I hasten to transmit to you an extract from a letter which I have received from him, and which I request you to insert in one of your next numbers.

"It

"It had long ſince been obſerved," ſays Citizen Leroux, "that the bulbous roots of ſome plants contained a mucilaginous ſubſtance; but no one had yet attempted to extract it, and ſtill leſs to analize it. A particular circumſtance having given me occaſion to employ the bulbs of the *Hyacinthus non ſcriptus*, I was ſo much ſurpriſed at the great degree of viſcoſity which I found them to poſſeſs, that I did not ſuffer the favourable opportunity to eſcape me, which preſented itſelf, for ſubjecting theſe roots to various experiments. It would be ſuperfluous here to give an account of all the different trials which I have made; it will be ſufficient for the preſent to inform you, that, having reduced 50 kilogrammes of the above-mentioned bulbs into a paſte, by pounding them in a mortar, I diluted this paſte with a ſufficient quantity of water: the liquor, having been ſtrained through a fine piece of linen, was afterwards evaporated to the conſiſtence of a thick ſyrup. In this ſtate it was poured into moulds of tinned iron, which were immediately placed in a ſtove.

The deſiccation took place pretty rapidly; and when it was completed I found, at the bottom of each mould, a brittle tranſparent ſubſtance, which exhibited all the external characters of a real gum.

The 50 kilogrammes of the bulbs, which I employed, yielded me 8 kilogrammes of this gummy product.

I compared this product with various kinds of gums, and found that it poſſeſſed the ſame properties; for, 1. treated with nitric acid, it yielded a twelfth of its weight of oxalic acid.

2. Diſ-

2. Diffolved in water, it rendered this fluid very (tinctucent).

3. This folution, left to itfelf in a rather warm temperature, foon grew four and mouldy.

4. Mixed with alcohol, it became turbid, and depofited a white flaky matter.

5. By diftilling the dried gummy matter in a retort, I obtained the following products: phlegm, a very fmall quantity of oil, and the pyro-mucous acid. All thefe fluids had the fmell of burnt bread, &c.

It is probable that this matter, as it exifts in this root, is perfectly colourlefs: indeed I think it may be proved; for, having cut feveral pretty large bulbs tranfverfely, I obferved that the fluid, which flowed out fpontaneoufly, dried upon the furface that had been laid bare, and formed a very tranfparent, and entirely colourlefs pellicle.

The quantity of gum that may be extracted from thefe roots is fufficiently confiderable to render its extraction an object worthy of attention. I have endeavoured to calculate the expences with which it would be attended; and it already appears to me, that if the extraction were carried on upon a large fcale, it would not only repay the cofts, but one might alfo hope to obtain fome profit from it.

However, it is evident that it cannot as yet be in my power to eftablifh data with refpect to this fubject, fufficiently exact to be relied upon.

Ere long, I hope, the experiments, of which I now give a fuccinct account, will be completed. I fhall then inform you of all the refults which I fhall have obtained, and particularly enlarge upon the

the uses to which this new gum, which I have extracted, may be applied."

Since I received this letter, I have been informed, that Citizen Leroux, having prosecuted these experiments, imagines that he has succeeded, by a very simple process, in converting the above-mentioned gum into a substance analogous to the amylaceous matter. I have even seen a specimen of the gum thus prepared, and found that it certainly had very much resemblance to starch.

However, before the practicability of converting the gum into starch can be considered as established, it would be necessary that farther experiments should be made. This Citizen Leroux proposes to do; and if the results answer his expectations, he will not delay to make them known in the Memoirs which he intends shortly to publish upon this subject.

LIX. *List of Patents for Inventions, &c.*

(Continued from Page 288.)

MATTHEW MURRAY, of Holbeck, in the parish of Leeds, Yorkshire, Engineer; for an improved method of constructing the air-pump, and sundry other parts belonging to a steam-engine, by which a considerable saving will be made in the consumption of fuel, and an increased power obtained. Dated August 11, 1801.

WILLIAM

WILLIAM FITZGERALD, of Grays-Inn, Middlesex, Esquire; for a mathematical instrument to be called "The Marine Level," the properties of which are to shew every deviation from the horizontal plane of ships and vessels, and which is also applicable to various purposes in surveying, levelling, and ascertaining vertical and perpendicular situations. Dated August 11, 1801.

BENJAMIN HAWKINS, late of Saratoga, in the State of New York, in the United States of America, but now of Red Lion-street, Clerkenwell, Middlesex, Merchant; for a new floating mill or engine to be worked by tides and currents of water for grinding all sorts of grain, and various other purposes. Dated August 20, 1801.

LIONEL LUKIN, the younger, of Conham-house, Gloucestershire, Esquire; for a new method of giving power to machinery by the application of air and water. Dated August 20, 1801.

WILLIAM PARKES, of Newington Butts, Surrey, Professor of Philosophy; for a perpetual power that will give motion to all kinds of machinery, mills, engines, carriages, ships of war, mercantile, and other vessels, lighters, craft, and boats of every description. Dated August 20, 1801.

JOHN THEODORE KOSTER, late of Lisbon, but now residing in St. Andrew's-Court, Holborn, Middlesex, Merchant; for a new method of building carriages. Dated August 31, 1801.

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REPERTORY OF ARTS AND MANUFACTURES.

NUMBER XC.

Printed by Nichols and Son, Red-Lion-Paffage, Fleet-Street, London.

LX. *Specification of the Patent granted to Mr.* George Godfry, *of Tufton Street, in the Parifh of Saint John, Weftminfter, in the County of Middlefex, Organ-builder; for a Tamborine, Tabor, or Drum and Pipe, and to annex or join the fame in or to Barrel-organs, and Mufical Inftruments, and to make, conftruct, and build, fuch Barrel-organs, and Mufical Inftruments, for the fame, fo as to beat and play the faid Tamborine, Tabor, or Drum and Pipe, therewith at Pleafure.*

Dated December 8, 1789.

TO all to whom thefe prefents fhall come, &c. Now know ye, that I the faid George Godfry (in compliance with, and in purfuance of, the faid power, in the faid in part recited letters patent contained) by this inftrument in writing, under my hand and feal, do afcertain, and more particularly defcribe the nature of my faid invention, in the faid letters patent mentioned, and

declare the ſame to be in manner and form following; that is to ſay: I make the frames of the tamborine, tabor, or drum, in two or more parts, and ſquare, round, oval, or other form, and of wood, copper, braſs, tin, iron, ſteel, or other metal, and I head or cover the ſame with parchment, vellum, leather, ſilk, oil-cloth, or braſs. I make a ſtraining frame for the ſame, and ſhaped according to the form and make of the tamborine, tabor, or drum, or nob, and of wood, or of braſs, or other metal, and put and place the ſtraining frame in the inſide of the ſaid tamborine, tabor, or drum, and I unite the frames ſo headed, or covered, by ſcrews, in and through the ſame, and nuts thereon, or by pins, wires, or other faſtenings, and to the ſaid tamborine, tabor, or drum, is the common or uſual ſnare; and the ſaid tamborine, tabor, or drum, ſo made, I annex to barrel-organs, or other muſical inſtruments, by firſt conſtructing and making, or building ſuch barrel-organ, or other muſical-inſtruments, after the common and uſual manner, and to be played upon after the uſual method with the following additions; that is to ſay: if a barrel-organ, I prick or cauſe to be pricked on the barrel, pins, for the purpoſe of making a hammer or drum-ſtick beat on the ſaid tamborine, tabor, or drum, according to the time of the tune and tunes ſet on the barrel with a key in the key frame, to touch and take the ſaid pins in playing; and I alſo prick, or cauſe to be pricked, in and upon the barrel, ſtaples, for the purpoſe of making the ſaid hammer or drum-ſtick beat to time, and diſtinguiſh and regulate the dance with a key in the key-frame of the organ, to touch and take the ſaid ſtaples in playing; and the

the ſaid tamborine, tabor, or drum, made as aforeſaid, or otherwiſe, as after-mentioned, I fix or faſten to and upon a bar, or piece of wood, or bar, or piece of braſs, or other metal, which reaches unto or lies between the two ends of the organ, at the one end whereof is a joint, or hinge, and is fixed, or faſtened, to the caſe of the organ, and the other end reſts upon the caſe or frame of the organ, or on a draw-ſtop or key, in the organ, made for raiſing or lowering the tamborine, tabor, or drum, ſo as the hammer or drum-ſtick may beat harder or ſofter at pleaſure. I fix or cauſe to be fixed in the inſide of the caſe, or on the frame of the organ, a frame whereto I hang, or cauſe to be hung, the hammer or drum-ſtick, with a ſpring thereto annexed, and a wire or rod made of copper, iron, or other metal, or ſlip of wood, from the end of the hammer or drum-ſtick to the key fixed in the key-frame, which comes unto and upon the ſaid pins pricked as aforeſaid, for the purpoſe of making the hammer or drum-ſtick beat to time. I make or cauſe to be made in the frame or caſe of the organ a ſtop, whereto is annexed a ſtring or wire which paſſes acroſs the organ and through the frame whereto the hammer or drum-ſtick is hung, and then faſtened to the drum-ſtick or hammer, and whereby the hammer or drum-ſtick is made to beat or be ſilent at pleaſure. And I otherwiſe make the hammer or drum-ſtick to beat to time, and diſtinguiſh or regulate the dance by a lever or movement which I make, or cauſe to be made, and hung in the frame of the organ-caſe, or to a frame or bar thereto annexed or faſtened, and whereto is joined

a wire or rod of copper, braſs, or other metal, or ſlip or piece of wood, which reaches unto and is united with the key in the key-frame of the organ, which comes unto and upon the ſtaples pricked upon the barrel for that purpoſe. And I alſo annex, or cauſe to be annexed, with the ſaid tamborine, tabor, or drum, to the ſaid organ, or other muſical inſtruments, one or more pipe or pipes placed, fixed, or faſtened, horizontally, or upright, in ſuch organ, or muſical inſtrument, tuned to the ſaid tamborine, tabor, or drum, and to play therewith or not at pleaſure, by a key or keys on the barrel pricked for that purpoſe. I alſo join, unite, fix, or faſten, the tamborine, tabor, or drum, in the inſide of the organ, by hanging the ſame on edge, by a wire, ſtring, or other faſtening, or by laying the ſame horizontally or flat, on one or more wires, or ſtrings, fixed and running from ſide to ſide, or end to end, of the organ; and over the above-mentioned key-frame I make a hammer or drum-ſtick of a ſize proportionable, of ivory, ebony, wood, or metal. I hang or fix the ſame in a frame at one ſide or end of the organ, and over or on one ſide of the tamborine, tabor, or drum, with a ſpring made of iron, ſteel, or other metal, thereto, and to the frame annexed or faſtened, and to which is fixed or faſtened one end of a ſtring or wire; and the other end of the ſaid ſtring or wire is fixed to a ſtop in the end or ſide of the organ, and a ſtop-key, to raiſe or fall the ſaid tamborine, tabor, or drum, and thereby the ſaid hammer or drum-ſtick is made to ſtrike or beat hard or ſoft, or not to beat at all as moſt agreeable, and at pleaſure. To the hammer or drum-ſtick is faſtened

faſtened or annexed alſo a line or rod which reaches the key-frame of the organ and is fixed to a key that comes to the barrel of the organ, whereon is pricked pins which regulate the beat of the hammer or drum-ſtick to the tune. I alſo fix a lever on the inſide, which is raiſed or lowered by a ſtop-key; from the lever is hung or fixed a wire, or rod of braſs, iron, or other metal, which joins to the key in the key-frame which reaches the barrel, whereon is pricked ſtaples to regulate the ſets and changes in the dance, or time to be obſerved. The pipe or pipes ſo placed in the organ as before mentioned, is and are filled and blown by the bellows in the organ.

I annex the ſaid tamborine, tabor, or drum, and alſo the pipe or pipes tuned thereto, in other muſical inſtruments by placing the ſame therein, and faſtening them thereto in ſuch way and manner as before deſcribed; and as the built of ſuch muſical inſtruments permit; and the ſame are played and actuated upon by a key or keys made in ſuch muſical inſtruments for the purpoſe, and by the bellows to ſuch inſtruments. In witneſs whereof, &c.

LXI. *Specification of the Patent granted to Mr.* Samuel Holemberg, *of Silver Street, Bridgewater Square, in the Parish of St. Giles Cripplegate, in the City of London, Goldsmith; for Locks or Fastenings for general Uses, on a new and improved Construction.* Dated June 24, 1801.

WITH A PLATE.

TO all to whom these presents shall come, &c. Now know ye, that in compliance with the said proviso, I the said Samuel Holemberg do hereby declare, that my said invention is described by the drawings and explanation hereunto annexed, (see Plate XVIII); Fig. 1, the front of the lock finished; 1. the four fastening screws; 2. flat plate; 3. the box; 4. key hole; 5, 5. catch fastening to the door-post, &c. with two screws. Fig. 2; 1. second or inner plate on which the key turning opens number 4; 2, 3. screws fastening inner plate to the bottom of lock; 3. spring flat bolt to double fasten the lock; 4 circular or principal bolt; 5. key-hole. Fig. 3; 1. spring screw; 2. inside tumbler, designed for greater security of the principal bolt, as appears from the drawing; 3. the orbicular bolt, the principle of the whole, for security unequalled; 4. key-hole, exhibiting foot of the key; 5. stopper, for the recurrency of principal bolt; 6. quadra-circular conductor, for the principal bolt; 7. the catch. Fig. 4; a fastening for sashes, shutters, and doors, upon the same principle with the above described. The dimensions, thickness, works, &c. may be varied at pleasure, according to the intended use and designation of the locks and fastenings. In witness wherof, &c.

LXII.

Fig 2.

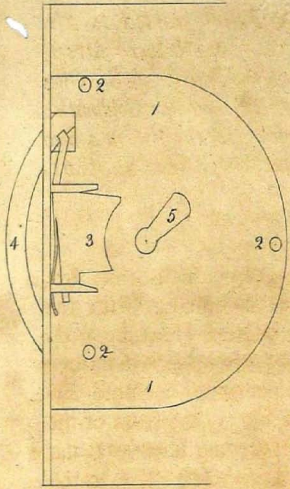


Fig 1.

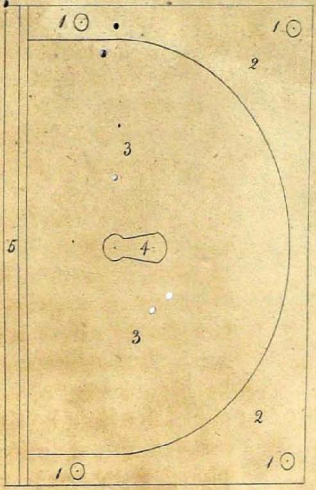


Fig 4.

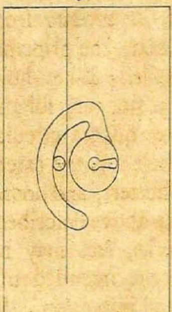
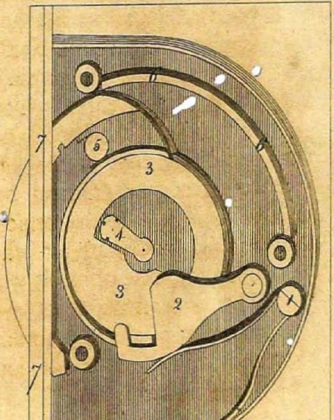


Fig 3.



LXII. *Specification of the Patent granted to* John Frederick Chabannes, *of Welbeck Street, in the Pariſh of Saint Mary-le-bone, in the County of Middleſex, Eſq. for a Machine for ſeparating Coals, and a Compoſition for making ſmall Coals into Cakes or Bricks to be uſed for Fuel.*

Dated December 16, 1799.

WITH A PLATE.

TO all to whom theſe preſents ſhall come, &c. Now know ye, that in compliance with the ſaid proviſo, I the ſaid John Frederick Chabannes do hereby declare, that the nature of my ſaid invention, and the manner in which the ſame is to be performed, and the effects thereof, are to be produced, is particularly deſcribed and aſcertained as follows; that is to ſay, coals conſiſting of great and ſmall mixed together ſuch as are uſually bought in the pool in the river Thames for conſumption in the cities of London and Weſtminſter and their environs, are to be diſcharged or thrown upon grates or gratings of the deſcription hereinafter contained, which grates or gratings are to be fixed either horizontally or on an inclined plane; and, by means of ſuch diſcharge, and throwing of the ſaid coals, the ſmall coals will be ſeparated from the large. The grates or gratings are to be conſtructed either of wood or metal, and are to be of any length or breadth ſuited to the place where they are fixed, and to have bars at a diſtance from each other not leſs than a quarter of an inch, nor more than an inch and an half. The form of theſe grates or gratings is particularly deſcribed in the

the plates or figures delineated in the margin hereof. (See Plate XIX.) The compoſition is to conſiſt of the ſmall coals ſo ſeparated as abovementioned from the large coals, and a ſmall quantity of earth, clay, cow-dung, tar, pitch, broken glaſs, ſulphur, ſaw-duſt, oil-cakes, tan, or wood, or of any other combuſtible ingredient, to be mixed together and ground with a wheel in water in a wooden veſſel. The compoſition, together with the water, is then to be conveyed by pipes or any other conductor into pits or holes of any dimenſions, made for that purpoſe, to be lined with tiles or bricks cemented together with water, except in the centre where a drain or watercourſe is to be cut below the pit or hole, and ſuch drain or watercourſe is to be covered over with uncemented tiles, by which means the water will paſs off into the drain or watercourſe, and leave the compoſition in the pit or hole. The compoſition is then to be moulded into brick-cakes or balls, and put on a frame to dry; and when dry is fit for uſe as fuel. In witneſs whereof, &c.

Reference to the Plate.

A. Plan of the grate or grating.

B. Veſſel in which the coals are raiſed from the barge, and from whence they are thrown on the grate or grating to ſeparate them.

C. The profile of the grate or grating with the coals running on it.

D. is the ſtage where the ſmall coal is received.

LXIII. *Specification of the Patent granted to* Jervas Wright, *of Cranage, in the County of Chester, Gent.; for a Machine upon an entire new Principle, for Sowing Wheat, Beans, Peas, and other Grain, and Seeds, which may be fixed to a Plough, or otherwise, and may be made to any Size or Dimensions required.*

Dated July 30, 1784.

WITH A PLATE.

TO all to whom these presents shall come, &c. Now therefore know ye, that I the said Jervas Wright do, by this instrument under my hand and seal, in pursuance of such proviso, in the said recited letters patent contained, and in compliance therewith, declare that the plans or drawings to this instrument annexed, and the description thereof, and reference to the same, hereinafter contained, do particularly describe and ascertain the nature of my said invention, for which such letters patent were granted to me as aforesaid, and in what manner the same is to be performed; premising and wishing it to be particularly understood, that the size and dimensions of the machine and its component parts herein described, are taken from that which I myself have used, and from which the annexed drawings are made, but that they may be made of a larger size if required, or even of a smaller size, but this I would not recommend, as I think the dimensions herein given small enough for any purposes of real utility: the drawing, marked A, (see Plate XX.) represents the machine as fixed to a plough-beam; and one side of the box or

or caſe is taken away for the purpoſe of diſplaying as much as poſſible the mechaniſm of it, and the way in which it works; and it may be fixed to the beam of any plough, and this is the way in which it ſhould be uſed when it is meant to ſow only one row under furrow; or the machine may be ſo varied as that the motion may be communicated to more ſeed plates than one, and theſe being fixed to a drilling inſtrument, may be contrived to ſow two or four rows at once; but the account here intended to be given is of that intended to ſow only one row; the ſeed-plates, ſo called becauſe they are the means of ſowing and diſtributing the ſeed, muſt be adapted to the nature and magnitude of the ſeed, or grain, intended to be ſown, and they may be eaſily and ſoon changed at the pleaſure of the uſer to ſow different kinds of ſeed or grain as will hereafter appear; the ſeed or grain is to be put into a box, canniſter, or hopper B, at the upper part of the machine, and the ſeed-plates which are round, flat, and made of braſs, receive their motion from a wheel paſſing upon the ground; theſe ſeed-plates turn horizontally between the bottom of the box B in which the ſeed is put C, and the top of the lower box or caſe D; the channels or apertures in them are ſo ordered as to diſpenſe a limited and certain quantity of the ſeed or grain intended to be ſown, which quantity may be increaſed or diminiſhed, upon any given ſpace or length of furrow, by changing the pinion-wheel and adding another with a greater or leſſer number of teeth, whereby the plate moves quicker or ſlower with relation to the movement of the plough. A block of wood E, which is the baſis or foundation of the machine, is fixed on the under-

under-ſide of the plough-beams; by means of two long iron bolts theſe paſs through the block and through the plough-beam, and are ſcrewed together on the upper-ſide the plough-beam: this wooden block ſhould be ſeventeen inches long, three inches broad, and three inches deep. To this block of wood E, on the left hand is fixed an iron frame F, which projects about ſix inches; the two ſtrong iron arms G, which ſupport this frame, are ſhouldered, and paſs through the arms of an iron plate, and then through the block of wood E. The frame F is the ſegment of a circle, the radius of which is about ſix or ſeven inches; and the cheeks of it are connected together at top and bottom by two thin iron bars rivetted into the two cheeks: the open ſpace between the two ſemi-circular cheeks is about three inches, and the range between the cheeks is about ſeven inches; on the left-hand ſide this block of wood, and cloſe upon it, there is an univerſal joint H, in the iron axis I, from this joint to the left hand, for ſix inches the axis I is perfectly round, and about three-fourths of an inch diameter; on this part of the axis there is a wooden roller K, buſhed with braſs, about five inches long and three in diameter at the larger or outer end, and one inch and a half at the ſmaller: this roller plays up and down the open range in the iron frame, and effectually prevents the wheel upon the ground from having any movement ſideways, which it otherwiſe would have. From the round part of the axis upon which the roller plays, the axis is continued ſquare for two inches and a half more, with a further allowance of half an inch, which is formed into a ſcrew; the large wheel upon the ground L, which moves the whole machine,

chine, has a ſquare mortiſe in its centre, which exactly correſponds with the ſquare part of the iron axis I; when this is put on and fixed by the nut, the wheel and axis turn together: this wheel gives movement to the ſeed-plates. I have fixed on twenty-one inches diameter for the large wheel on the ground, as the moſt convenient height for the ploughs commonly uſed in the part of Cheſhire where I live; but it may be made more or leſs, as ordered, and conſtructed of wood hooped with iron, or of caſt iron; the wheel, when fixed to work, will be diſtant from the plough-beam, on the left hand or land-ſide, about ten inches. By the contrivance of the univerſal joint and the roller, the wheel, in its circular motion on the ground, riſes and falls, and paſſes over ſtones, or any other irregularities, without affecting the movement of the plough, or ſtraining the inſide, or other movements of the machine; from the univerſal joint on the left ſide, the block of wood before-mentioned, the iron axis I is continued through the block; and, about two inches and a half to the right-hand ſide of it, there is a perpendicular plate of iron, about one inch and a quarter broad, three inches long, and a quarter of an inch thick; on each ſide the block of wood theſe are let in, and buſhed with braſs, or theſe plates may be formed of caſt iron; and through theſe the ſpindle or axis from the great wheel paſſes: it is here half an inch diameter, and perfectly round for three inches in length; the other two and a half ſquare; on this ſquare part of the axis is fixed the pinion M, with eight leaves or bars; this pinion muſt be made of hardened ſteel; or it may be made of caſt copper, with a ſmall allowance of tin to harden it; the pinion muſt be nearly two inches

inches long, and one inch and a quarter diameter, with a ſquare mortiſe through it, correſponding with the ſquare of that part of the axis I, upon which it is fixed. Betwixt the pinion and the plate, on the right-hand ſide the block of wood, there muſt be put a collar of braſs, to make up the whole length of two inches and a half: a broad-headed ſcrew, at the extremity of the iron axis I, fixes all this work; and, when it is neceſſary to repair, clean, or oil any part of the movement, this broad-headed ſcrew being taken out ſets all at liberty: the pinion and collar come off on the inſide the box N; and the round ſpindle, or axis I, comes out on the outer, or other ſide; the long pinion M is eſſentially neceſſary, as it admits of pinion-wheels O, of different diameters, with any number of teeth, from ſixteen to forty-eight, to work upon it, from one common centre, as will appear afterwards; the block of wood before-mentioned forms the left-hand ſide of the box N; two boards, three quarters of an inch thick, form the front and back part of the box; a board, three quarters of an inch thick, forms the bottom; and on the right-hand ſide is a door that opens outwards; the top, or cover, is a braſs plate, about ſeven inches ſquare, and a quarter of an inch thick: when the whole is put together, it forms a cube of near ſix inches withinſide. In or near the centre, in the bottom of the box, is a round hole, three quarters of an inch diameter; on the outſide of the bottom is fixed a braſs plate, let in level with the ſurface, about four inches long, by one inch and a quarter broad, with a hole three quarters of an inch diameter; by means of two ſtaples, rivetted into this plate, a flat double iron bolt P, with a ſpring upon it, ſlides into

a re-

a rebatement, turned out of the upright iron ſhaft, or ſpindle Q, as will be ſeen in the drawing of the ſeparate parts; by ſlipping the bolt back, the upright ſpindle Q is readily taken out, and by puſhing it forwards it confines the ſpindle from riſing or ſinking, and to all intents anſwers the purpoſe of a ſtep or ſtop for the ſpindle to turn upon; the upright ſhaft, or ſpindle Q, is about eight inches long, the lower part projecting under the bottom of the box, through the bolt P, about an inch; then a circular grove for the bolt P to ſlide into; this is turned out of the iron about one-eighth of an inch deep, and as much wide; the ſhaft is round at the lower end, and three quarters of an inch diameter; at two inches from the circular grove it becomes ſquare: on this ſquare part the different pinion-wheels O are fixed; the upper part is again turned round; this upper round part paſſes through a round hole in the braſs top D of the box N, correſponding with the diameter of the round part of the ſpindle; the ſpindle riſes one quarter of an inch above the upper ſurface of the braſs-top D; and here it is again formed into a ſquare of half an inch; on this ſquare ſhoulder the different ſeed-plates are put, by a ſquare mortiſe, in their centres, correſponding with this ſquare upper projecting part of the upright ſpindle Q; in order the better to ſhew this iron ſpindle, a ſeparate drawing of it is added, marked Q q. The ſeed-plates for different ſeeds differ ſomewhat, but are all round, flat, and made of braſs: as they cannot be ſeen in the place where they work between C and D, ſeparate drawings of them are therefore added. That for wheat R is ſomething more than ſix inches diameter, and rather more than one-eighth of an inch

inch thick; two open channels or circles are cut through it, near the circumference; theſe are connected by bars alternately diſpoſed, ſo that there is little or no interruption to the ſeed dropping, as the plate turns round; theſe open ſpaces, with the interpoſing rim, are about an inch wide. In the plate for beans or peas S, there is only one open circle, about an inch wide, with ſixteen thin partitions, to connect the rim with the body of the plate; this is braſs, nearly half an inch thick, and of the ſame diameter as the other; the partitions are fluſh with the bottom of the plate, but do not riſe more than half-way up the rim on the upper ſide: this will better appear from the drawing S. The plate for turnips, rape, lucern, or other ſmaller ſeeds T, muſt be about ſix inches diameter, ſomething thicker than the diameter of a turnip ſeed, but not equal to two; the holes muſt be made as appears in the drawing, and to open ſucceſſively upon the opening in the braſs table D, upon which all the ſeed-plates turn, and made large enough to contain four or five ſeeds, more or leſs, as they are ordered; for in this article perſons differ about the quantity of ſeed they think neceſſary to be ſowed in a given ſpace. In order to connect the ſeed-box B with the lower box N, between which two the ſeed-plates move, as above deſcribed, there muſt be fixed, near the four corners of the braſs plate D, on the top of the box N, four round upright pillars; theſe are about one quarter of an inch diameter, and about an inch and a half long: they may be made of braſs, or iron, or may be rivetted into the four corners of the braſs top of the box N. Four round mortiſes are to be made in the bottom of the ſeed-box B, correſponding with theſe upright pillars; the

the ſeed-box muſt be put on theſe pillars, and ſlipped down, and then, by means of four thumb-ſcrews, which ſcrew into the bottom of the box B laterally and horizontally, and act againſt the upright pillars, the box may be kept in its poſition; the bottom of the ſeed-box B is a ſquare piece of wood (beach, mahogany, or other cloſe-grained wood, is what I have uſed), nearly ſeven inches ſquare, and one inch and a quarter thick, perfectly ſmooth and level; this has four holes through it, correſponding with the four upright pillars before-mentioned, and likewiſe a large ſemicircular opening, five inches long, and an inch wide; through part of this opening the ſeed deſcends from the box above, and part of it is occupied by the bruſhes, hereafter mentioned; but, as this cannot appear in the machine when it is together, a ſeparate drawing is made of it U, which repreſents the under-ſide of it, with the bruſhes that act upon the ſeed-plates: this wooden table forms the bottom of the ſeed-box or hopper B; this hopper may be formed of wood, tin, copper, or rolled iron, and made to contain from one gallon to two; a triangular piece of wood or braſs is fixed, by a ſcrew, near the centre of this wooden table U, and is made to ſlide and cover the opening in it, towards the right hand of it, for about half-way, and under the briſtle-bar *t*, and the bruſh *t t*, hereafter mentioned, are placed: it is made to ſlide, for the purpoſe of taking out, repairing, or changing the bruſhes, and a ſeparate drawing is made of it U U, which repreſents the upper ſide of the bottom, and the triangular ſliding-cover; when the ſeed-plate is put upon the ſquare ſhoulder of the upright ſpindle Q, which projects above the braſs-top D of the lower box N, then the

the seed-box or hopper B must be put on, and fixed by the lateral horizontal thumb-screws, and the seed-plate will then, by the action of the great wheel L, by means of the pinion M and the pinion-wheel O, turn horizontally upon the brass table D, without any resistance but what is occasioned by the seed passing under the bristle-bar; there must be a semicircular opening in the brass table D (of which, as it cannot be seen in its place in the drawing, a separate drawing is made of it V), about two inches long, and one inch wide; this must be to the right of the bristle-bar *t*, in the table C or U, that nothing may fall through it from the opening in C or U, till it has passed under the bristle-bar *t*; and the opening in the table C or U, being to the left of the bristle-bar *t*, no seed can escape when the seed-plate stands still; but so soon as this is put in motion, whatever is received from the seed-box into the open channels of the seed-plate, as they pass under this opening, is forced by the divisions in the seed-plate under the bristle-bar *t*; and so soon as they pass under that bar, they drop through the opening in the brass table D or V into a perpendicular conducting pipe W, which conveys them downwards to the moveable conducting pipe X, and that deposits them upon the ground; this pipe W is made of tin, and joins close under the opening in the table D or V, and is as wide at top as that opening, narrowing as it descends through the box N, and is fastened against the inside of the front of that box; on the under or outside of the bottom of the box N, is fixed an oblique flat conducting pipe, made of strong tin, or thin iron, or copper, X; this comes immediately under, and receives the seed from the pipe

 W;

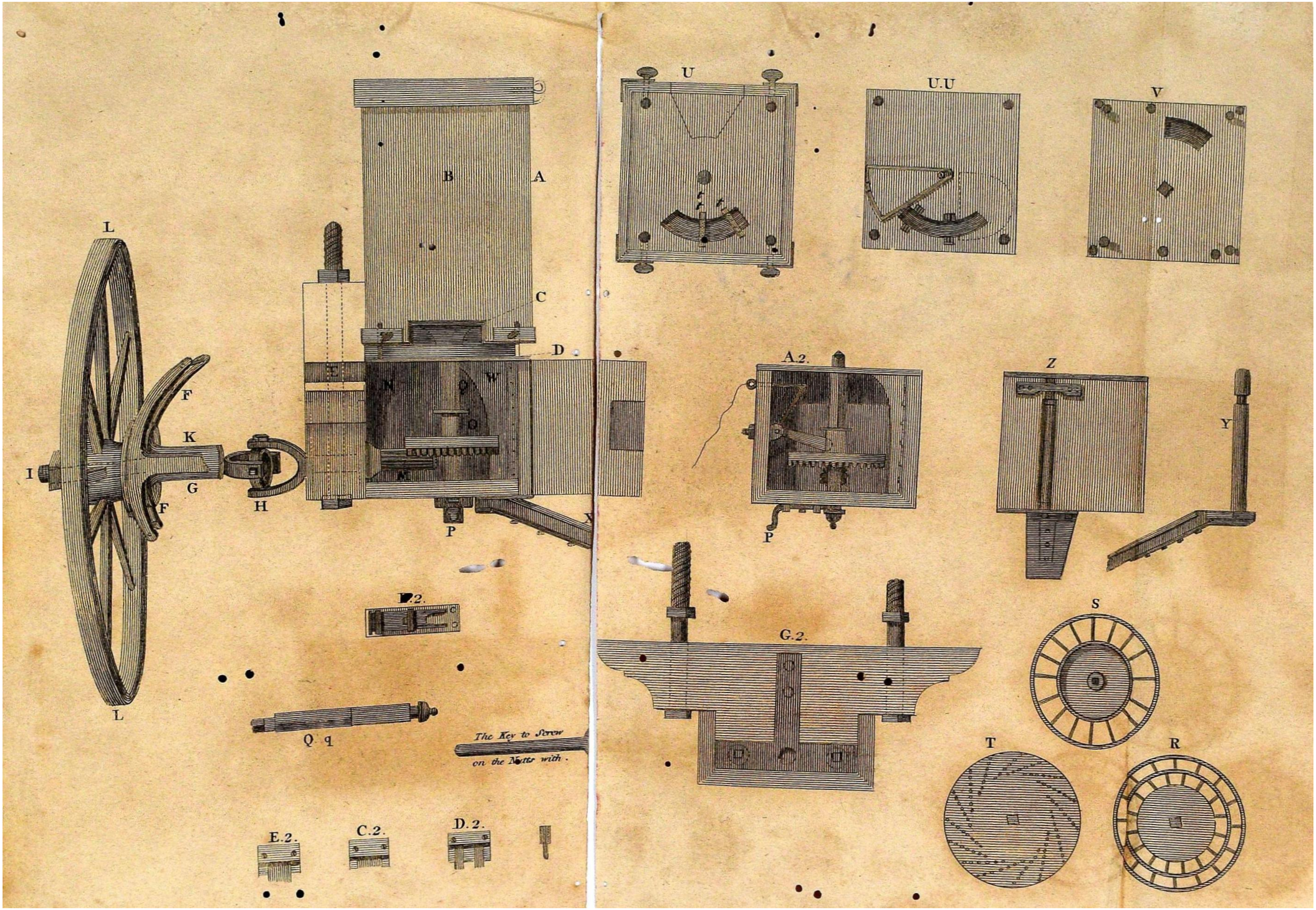
W; this pipe X turns on a round iron rod or ſwivel, that is paſſed through a hole in a flat piece of copper, projecting from the bottom of the box N, and is fixed on the fore part of the box N on the outſide; and by means of a ſtrong ſpring acting againſt this rod or ſwivel, in a groove turned out of it near the top, and the upper end of the rod being confined in a round iron ſtaple that will admit it to turn round in it, the rod and pipe are kept from ſlipping down, and may be turned to the right or left under the bottom of the machine, to drop the ſeed in what part of the furrow the uſer thinks fit; but, as this pipe, and the rod and ſpring, cannot be ſeen in the machine as put together, a ſeparate drawing of the pipe and rod are made Y, of the front part of the box, with the ſpring and ſtaple which confine it, Z; the ſeed-plates are put in motion by the motion of the wheel upon the ground L, which is communicated to them when they are put on the ſpindle Q, by means of the pinion M acting upon the pinion-wheels O; theſe pinion-wheels O may be made of braſs, or caſt or forged iron, and in ſize may be from two inches diameter to five, with any number of teeth required. What I have uſed have been wheels with twenty-four, thirty-two, and forty teeth; the rim of the wheels is about half an inch deep, and a quarter of an inch thick; on the upper ſide of the centre there is a collar, which riſes about an inch above the upper ſide of the wheel; there is a ſquare collar through this mortiſe, correſponding with the ſquare of the upright ſpindle Q, upon which it is put, lodging upon that part of the ſpindle towards the bottom where it is round; on the collar, on the upper part, all round is a ſhoulder projecting ho-

horizontally a quarter of an inch, under which comes the end of the horizontal arm of a lever of iron of this form ⊾, fixed to the inſide of the box N, on that ſide that is next the ploughman, by means of a ſtrong wire paſſing from the top of the upright arm of the lever ⊾ through the box N, towards the plough-man, and a cord from the wire to the plough-man; he can at any time raiſe up the pinion-wheel O, ſo as to clear it from the pinion M, and ſtop it from working or moving the feed-plate as long as he pleaſes, though the plough be going on, and the wheel on the ground L in motion all the time, and again, by letting go the cord the wheel O will fall immediately down upon the pinion M, and inſtantly renew its work; and by this means turnip, rape, lucern, and other ſmaller feeds, may be ſown in drills or rows, in what intervals the uſer thinks proper. As the lever is fixed on the ſide of the box N, which in the drawing is taken away to ſhew the mode in which the machine works, a ſeparate drawing is made, A 2; which repreſents the ſituation and operation of the lever upon the pinion-wheel. The operation of this lever gives the machine ſeveral conveniences, particularly in going to the field, or returning; it likewiſe gives the ploughman a perfect command over the inſtrument. If intervals are required betwixt the rows, as in ſowing peas, beans, or wheat, this is ſoon effected by raiſing the pinion-wheel out of work, at the uſer's diſcretion; when it is kept in conſtant movement, and ſows the feed in every furrow, it is then the ſame as broad-caſt ſowing; with this difference, that one-half the quantity of feed may be ſaved, or in other words, the farmer may ſow what number of grains in every yard-length

of furrow he thinks proper. The wheat ſeed-plate I have in uſe delivers out, every revolution it makes, three drams in weight, with little or no variation; this weight, in counting, amounts to three hundred grains, or thereabouts. The firſt or large wheel on the ground is nearly ſixty-five inches in circumference. When the pinion-wheel, with twenty-four teeth, is in work, the plough will open a furrow one hundred and ninety-five inches, or nearly five yards and a half, for one revolution of the ſeed-plate, and the machine drop above fifty grains of wheat every yard. When the pinion-wheel with thirty-two teeth is at work, the plough will go ſomething more than ſeven yards; there would then drop ſomething more than forty ſeeds every yard. When the forty-toothed wheel is at work, the plough will go nine yards; and in that compaſs about thirty-four ſeeds would drop every yard. I have not computed the diſtance the plough goes, nor the number of grains dropped in a yard, with a mathematical exactneſs, becauſe, in an operation of this kind, it is not neceſſary: by making the channels in the ſeed-plates greater or leſſer, by changing the pinion-wheels for others with more or leſs teeth, the machine may be made to drop preciſely any quantity named. When it is neceſſary to change the pinion-wheel O for a different one, it is done immediately by drawing back the bolt P under the bottom of the machine, which lets the upright ſpindle Q fall down; the pinion-wheel is then taken off, another put on the ſpindle, the ſpindle replaced, with the upper end in the braſs-top of the box; and the bolt P ſliding upon the circular groove, in the lower end of the ſpindle, faſtens and fits it for

for work immediately: a ſeparate drawing of the bolt is added, marked B 2. What remains to be deſcribed are the bruſhes or bars of hogs' briſtles. Theſe are let into the large open ſpace in the wooden table C or U, before-mentioned, under the triangular ſliding cover above deſcribed, and ſtand perpendicular to the horizontal ſeed-plates: they are readily taken out to be repaired, and as ſoon replaced again. Their elaſticity prevents their injuring the corn, in paſſing under them. They are the only part of the machine that can fairly be injured by uſe; and, as theſe may require renewing, it will be neceſſary to be particular in deſcribing the manner of making them. The braſs frame conſiſts of two parts; the firſt a ſtrong plate of braſs, about one inch and a half long, and three quarters of an inch broad; upon this are rivetted two cheeks of braſs, about the eighth of an inch thick, and a quarter of an inch broad, ſo as to leave an open ſpace betwixt the cheeks an inch wide; the cheeks muſt be in length the thickneſs of the wooden table before-mentioned. When theſe are rivetted together, I call them one part of the frame; the other part conſiſts of a ſtrong braſs-plate, one inch and a half long by three quarters; two holes muſt be drilled through the former part, to admit two ſcrews; and this laſt muſt have two female ſcrew-holes. Fill the vacancy in the firſt part mentioned with the beſt Ruſſia briſtles; duſt ſome powdered roſin among them; fill it as full as it will contain; then apply the other part, and paſs two wires through the ſcrew-holes, to preſerve the communication; then put the whole into a hand-vice, and ſcrew it hard; apply the upper part to a hot iron, burn off the redundant briſtles, and continue

tinue the heat till the rosin is melted, and the whole cemented together; when it is cool, take out the wires, and put in the screws; the bristles below the cheeks must be cut off level with the cheeks, by a broad chisel; this brush or bar is fixed even with the upper surface of the feed-plate, and a separate drawing is made of it, C 2. The second brush, to the right of this, is made in the same manner; only a piece of brass is rivetted in the middle space, betwixt the two cheeks, to divide the brush into two parts; the bristles here are left longer than the cheeks, by the eighth of an inch. The use of this brush is to sweep out any grain that may accidentally lodge in the open channels of the wheat feed-plate, and force them back again down the conducting pipe: a separate drawing is made of this brush, D 2. The brush for beans and peas is made exactly in the same manner; only the bristles must not be cut off square with the cheeks of the brass frame, but left a quarter of an inch longer than the cheeks of the frame; when the bean-plate is intended to be used, the former brush for wheat, marked in the separate drawing C 2, must be taken out, and this put in its place; the second, or double brush D 2, need not be removed, as it does not act in that case: a separate drawing of this brush for beans and peas is added, marked E 2. I think fit to say one word more about the effect produced by means of the roller K and universal joint H, above particularly described; on which, with the horizontal movements of the feed plate, as applied to the purpose of this machine, I principally build my claim of right and property to this invention. The roller is contrived to move between a frame F, as above-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above-mentioned; by which the wheel is enabled to move up and down, and get over obſtructions, and is at the ſame time prevented from turning to the right or to the left, as it otherwiſe would do, or impeding the action of the pinion M with the horizontal wheel O, which is never interrupted by the riſing or falling of the wheel on the land L; and it has been found, on trial, that the two iron arms to this frame F ſhould be placed within about two inches of the lower part of the frame, as the large wheel never ſinks much below the centre of its motion, but, in paſſing over obſtructions, riſes greatly above; which diſtinction appears in the drawing. There is alſo another ſeparate drawing, G 2, which ſhews the iron plate through which the ſpindle paſſes into the box from the univerſal joint. In witneſs whereof, &c.

LXIV. *Method of fermenting a large Body of Flour with a ſmall Quantity of Yeaſt. By Mr.* JAMES STONE, *of Amport, Hampſhire.*

SUPPOSE you want to bake a buſhel of bread, and have not more than one tea-ſpoon full of yeaſt; put the flour into a kneading-trough, and take about three quarters of a pint of warm water, and the tea-ſpoon full of yeaſt, which if thick and ſteady the better; put it into the water, and ſtir it until it is thorougly mixed; then make a hole in the middle of the flour large enough to contain two gallons of water; pour

pour in your ſmall quantity of yeaſt, mixed with water as above; then take a ſtick, about two feet long, and ſtir in ſome of the flour until it is as thick as you would make batter for a pudding; ſtrew ſome of the dry flour over it, and let it reſt for about an hour, for in that time you will find this ſmall quantity raiſed ſo that it will break through the dry flour which you ſhook over it; then pour in about a quart more of warm water, and ſtir it with your ſtick as before, and leave it for two hours more; you will find it riſe, or break through the dry flour again; then add three quarts or a gallon more of warm water, and ſtir in the flour again; and in about three or four hours mix up the dough, and cover it warm. In four or five hours more you may put it into the oven, and you will have as light bread as though you had uſed a pint of yeaſt. It does not take above a quarter of an hour more time than the uſual way of baking; for there is no time loſt but that of adding water three or four times. When you find your body of flour ſpunged large enough, before you put in the reſt of the water, you ſhould, with both hands, mix that which is ſpunged and the dry flour altogether, and then add the remainder of warm water, and your dough will riſe the better and eaſier. The author aſſerts, that he conſtantly bakes this way; in the morning, about ſix or ſeven o'clock, he begins his firſt operation, in an hour's time he adds more water, in two hours more a greater quantity, about noon makes up the dough, and about ſix in the evening it is put into the oven; and that he has always good bread, never heavy, nor bitter. He adds, that the cauſe of heavy bread is not owing to the ſmallneſs

ſmallneſs of the quantity of yeaſt uſed, but to its not being uſed properly, for yeaſt is to flour what fire is to fuel—a ſpark of the latter will kindle a large body by only blowing it up, ſo a thimble full of the former, by adding warm water to it, will raiſe or ſpunge almoſt any quantity of flour.

Thus heavy bread is not owing to a deficiency in the quantity of yeaſt uſed, but to a deficiency of fermentation; for, if the dough is put into the oven before it is ripe, heavy bread is the natural conſequence.

In regard to the difference of ſeaſons, he preſcribes that in ſummer the water ſhould be blood-warm, and in cold froſty weather as warm as you can bear your hand in it without making it ſmart; taking care in winter to cover up your dough.

LXV. *Deſcription of a Sub-marine Veſſel or diving Machine, invented by Mr.* D. BUSHNELL, *of Connecticut.*

From the TRANSACTIONS of the AMERICAN PHILOSOPHICAL SOCIETY.

THE external ſhape of the ſub-marine veſſel bore ſome reſemblance to two upper tortoiſe ſhells of equal ſize, joined together; the place of entrance into the veſſel being repreſented by the opening made by the ſwell of the ſhells, at the head of the animal. The inſide was capable of

 containing

containing the operator, and air, sufficient to support him thirty minutes without receiving fresh air. At the bottom, opposite to the entrance, was fixed a quantity of lead for ballast. At one edge, which was directly before the operator, who sat upright, was an oar for rowing forward or backward. At the other edge was a rudder for steering. An aperture, at the bottom, with its valve, was designed to admit water, for the purpose of descending; and two brass forcing-pumps served to eject the water within, when necessary for ascending. At the top, there was likewise an oar, for ascending or descending, or continuing at any particular depth.—A water-gauge or barometer determined the depth of descent, a compass directed the course, and a ventilator within supplied the vessel with fresh air, when on the surface.

The entrance into the vessel was elliptical, and so small as barely to admit a person. This entrance was surrounded with a broad elliptical iron band, the lower edge of which was let into the wood of which the body of the vessel was made, in such a manner, as to give its utmost support to the body of the vessel against the pressure of the water. Above the upper edge of this iron band there was a brass-crown, or cover, resembling a hat with its crown and brim, which shut water-tight upon the iron band: the crown was hung to the iron band with hinges, so as to turn over sidewise, when opened. To make it perfectly secure when shut, it might be screwed down upon the band by the operator, or by a person without.

There were in the brass crown three round doors, one directly in front, and one on each side,

ſide, large enough to put the hand through — when open they admitted freſh air; their ſhutters were ground perfectly tight into their places with emery, hung with hinges, and ſecured in their places when ſhut. There were likewiſe ſeveral ſmall glaſs windows in the crown, for looking through, and for admitting light in the daytime, with covers to ſecure them. There were two air pipes in the crown. A ventilator within drew freſh air through one of the air pipes, and diſcharged it into the lower part of the veſſel; the freſh air introduced by the ventilator expelled the impure light air through the other air pipe. Both air pipes were ſo conſtructed, that they ſhut themſelves whenever the water roſe near their tops, ſo that no water could enter through them, and opened themſelves immediately after they roſe above the water.

The veſſel was chiefly ballaſted with lead fixed to its bottom; when this was not ſufficient, a quantity was placed within, more or leſs, according to the weight of the operator; its ballaſt made it ſo ſtiff, that there was no danger of overſetting. The veſſel with all its appendages, and the operator, was of ſufficient weight to ſettle it very low in the water. About two hundred pounds of the lead, at the bottom for ballaſt, would be let down forty or fifty feet below the veſſel; this enabled the operator to riſe inſtantly to the ſurface of the water, in caſe of accident.

When the operator would deſcend, he placed his foot upon the top of a braſs valve, depreſſing it, by which he opened a large aperture in the bottom of the veſſel, through which the water entered at his pleaſure; when he had admitted a ſufficient quantity, he deſcended very gradually; if

if he admitted too much, he ejected as much as was neceſſary to obtain an equilibrium, by the two braſs forcing pumps, which were placed at each hand. Whenever the veſſel leaked, or he would aſcend to the ſurface, he alſo made uſe of theſe forcing pumps. When the ſkilful operator had obtained an equilibrium, he could row upward, or downward, or continue at any particular depth, with an oar, placed near the top of the veſſel, formed upon the principle of the ſcrew, the axis of the oar entering the veſſel; by turning the oar one way he raiſed the veſſel, by turning it the other way he depreſſed it.

A glaſs tube eighteen inches long, and one inch in diameter, ſtanding upright, its upper end cloſed, and its lower end, which was open, ſcrewed into a braſs pipe, through which the external water had a paſſage into the glaſs tube, ſerved as a water-gauge or barometer. There was a piece of cork, with phoſphorus on it, put into the water-gauge. When the veſſel deſcended the water roſe in the water-gauge, condenſing the air within, and bearing the cork, with its phoſphorus, on its ſurface. By the light of the phoſphorus, the aſcent of the water in the gauge was rendered viſible, and the depth of the veſſel under water aſcertained by a graduated line.

An oar, formed upon the principle of the ſcrew, was fixed in the fore part of the veſſel; its axis entered the veſſel, and being turned one way, rowed the veſſel forward, but being turned the other way rowed it backward; it was made to be turned by the hand or foot.

A rudder, hung to the hinder part of the veſſel, commanded it with the greateſt eaſe. The rudder was made very elaſtic, and might be uſed

for

for rowing forward. Its tiller was within the veſſel, at the operator's right hand, fixed, at a right angle, on an iron rod, which paſſed through the ſide of the veſſel; the rod had a crank on its outſide end, which commanded the rudder, by means of a rod extending from the end of the crank to a kind of tiller, fixed upon the left hand of the rudder. Raiſing and depreſſing the firſt-mentioned tiller turned the rudder as the caſe required.

A compaſs marked with phoſphorus directed the courſe, both above and under the water; and a line and lead ſounded the depth when neceſſary.

The internal ſhape of the veſſel, in every poſſible ſection of it, verged towards an ellipſis, as near as the deſign would allow, but every horizontal ſection, although elliptical, yet as near to a circle as could be admitted. The body of the veſſel was made exceedingly ſtrong; and to ſtrengthen it as much as poſſible, a firm piece of wood was framed, parallel to the conjugate diameter, to prevent the ſides from yielding to the great preſſure of the incumbent water, in a deep immerſion. This piece of wood was alſo a ſeat for the operator.

Every opening was well ſecured. The pumps had two ſets of valves. The aperture at the bottom, for admitting water, was covered with a plate, perforated full of holes to receive the water, and prevent any thing from choaking the paſſage, or ſtopping the valve from ſhutting The braſs valve might likewiſe be forced into its place with a ſcrew, if neceſſary. The air pipes had a kind of hollow ſphere, fixed round the

top

top of each; to secure the air-pipe valves from injury: these hollow spheres were perforated full of holes, for the passage of the air through the pipes: within the air-pipes were shutters to secure them, should any accident happen to the pipes, or the valves on their tops.

Wherever the external apparatus passed through the body of the vessel, the joints were round, and formed by brass pipes, which were driven into the wood of the vessel, the holes through the pipes were very exactly made, and the iron rods, which passed through them, were turned in a lathe to fit them; the joints were also kept full of oil, to prevent rust and leaking. Particular attention was given to bring every part, necessary for performing the operations, both within and without the vessel, before the operator, and as conveniently as could be devised; so that every thing might be found in the dark, except the water-gauge and the compass, which were visible by the light of the phosphorus, and nothing required the operator to turn to the right hand, or to the left, to perform any thing necessary.

Description of a Magazine, and its Appendages, designed to be conveyed by the Sub-marine Vessel to the Bottom of a Ship.

In the fore part of the brim of the crown of the sub-marine vessel, was a socket, and an iron tube, passing through the socket; the tube stood upright, and could slide up and down in the socket, six inches: at the top of the tube was a wood-screw, fixed by means of a rod, which passed through the tube, and screwed the wood-

screw

ſcrew faſt upon the top of the tube: by puſhing the wood-ſcrew up againſt the bottom of a ſhip, and turning it at the ſame time, it would enter the planks; driving would alſo anſwer the ſame purpoſe; when the wood-ſcrew was firmly fixed, it could be caſt off by unſcrewing the rod, which faſtened it upon the top of the tube.

Behind the ſub-marine veſſel was a place, above the rudder, for carrying a large powder magazine; this was made of two pieces of oak timber, large enough, when hollowed out, to contain one hundred and fifty pounds of powder, with the apparatus uſed in firing it, and was ſecured in its place by a ſcrew, turned by the operator. A ſtrong piece of rope extended from the magazine to the wood-ſcrew above mentioned, and was faſtened to both. When the wood-ſcrew was fixed, and to be caſt off from its tube, the magazine was to be caſt off likewiſe by unſcrewing it, leaving it hanging to the wood-ſcrew; it was lighter than the water, that it might riſe up againſt the object, to which the wood-ſcrew and itſelf were faſtened.

Within the magazine was an apparatus, conſtructed to run any propoſed length of time, under twelve hours; when it had run out its time, it unpinioned a ſtrong lock reſembling a gun lock, which gave fire to the powder. This apparatus was ſo pinioned, that it could not poſſibly move, till, by caſting off the magazine from the veſſel, it was ſet in motion.

The ſkilful operator could ſwim ſo low on the ſurface of the water, as to approach very near a ſhip, in the night, without fear of being diſcovered, and might, if he choſe, approach the ſtem or ſtern above water, with very little danger.

ger. He could sink very quickly, keep at any depth he pleased, and row a great distance in any direction he desired, without coming to the surface, and when he rose to the surface, he could soon obtain a fresh supply of air, when, if necessary, he might descend again, and pursue his course.

Experiments made to prove the Nature and Use of a Sub-marine Vessel.

The first experiment I made was with about two ounces of gunpowder, which I exploded four feet under water, to prove to some of the first personages in Connecticut that powder would take fire under water.

The second experiment was made with two pounds of powder, inclosed in a wooden bottle, and fixed under a hogshead, with a two-inch oak plank between the hogshead and the powder; the hogshead was loaded with stones as deep as it could swim; a wooden pipe descending through the lower head of the hogshead, and through the plank, into the powder contained in the bottle, was primed with powder. A match put to the priming, exploded the powder, which produced a very great effect, rending the plank into pieces; demolishing the hogshead; and casting the stones and the ruins of the hogshead, with a body of water, many feet into the air, to the astonishment of the spectators. This experiment was likewise made for the satisfaction of the gentlemen above mentioned.

I afterwards made many experiments of a similar nature, some of them with large quantities of powder; they all produced very violent explosions,

ſions, much more than ſufficient for any purpoſe I had in view.

In the firſt eſſays with the ſub-marine veſſel I took care to prove its ſtrength to ſuſtain the great preſſure of the incumbent water, when ſunk deep, before I truſted any perſon to deſcend much below the ſurface: and I never ſuffered any perſon to go under water without having a ſtrong piece of rigging made faſt to it, until I found him well acquainted with the operations neceſſary for his ſafety. After that I made him deſcend, and continue at particular depths, without riſing or ſinking, row by the compaſs, approach a veſſel, go under her, and fix the *wood-ſcrew* mentioned before, into her bottom, &c. until I thought him ſufficiently expert to put my deſign into execution.

I found, agreeably to my expectations, that it required many trials to make a perſon of common ingenuity a ſkilful operator: the firſt I employed was very ingenious, and made himſelf maſter of the buſineſs, but was taken ſick in the campaign of 1776, at New York, before he had an opportunity to make uſe of his ſkill, and never recovered his health ſufficiently afterwards.

Experiments made with a Sub-marine Veſſel.

After various attempts to find an operator to my wiſh, I ſent one, who appeared more expert than the reſt, from New York, to a fifty-gun ſhip, lying not far from Governor's Iſland. He went under the ſhip, and attempted to fix the wooden ſcrew into her bottom, but ſtruck, as he

 ſuppoſes,

ſuppoſes, a bar of iron, which paſſes from the rudder hinge, and is ſpiked under the ſhip's quarter. Had he moved a few inches, which he might have done, without rowing, I have no doubt but he would have found wood where he might have fixed the ſcrew; or, if the ſhip were ſheathed with copper, he might eaſily have pierced it: but not being well ſkilled in the management of the veſſel, in attempting to move to another place, he loſt the ſhip; after ſeeking her in vain, for ſome time, he rowed ſome diſtance, and roſe to the ſurface of the water, but found day-light had advanced ſo far, that he durſt not renew the attempt. He ſays that he could eaſily have faſtened the magazine under the ſtem of the ſhip, above water, as he rowed up to the ſtern, and touched it before he deſcended. Had he faſtened it there, the exploſion of one hundred and fifty pounds of powder, (the quantity contained in the magazine,) muſt have been fatal to the ſhip. In his return from the ſhip to New York, he paſſed near Governor's Iſland, and thought he was diſcovered by the enemy, on the iſland; being in haſte to avoid the danger he feared, he caſt off the magazine, as he imagined it retarded him in the ſwell, which was very conſiderable. After the magazine had been caſt off one hour, the time the internal apparatus was ſet to run, it blew up with great violence.

Afterwards, there were two attempts made in Hudſon's river, above the city, but they effected nothing. One of them was by the afore-mentioned perſon. In going towards the ſhip, he loſt ſight of her, and went a great diſtance beyond her: when he at length found her, the tide

ran

ran ſo ſtrong, that, as he deſcended under water, for the ſhip's bottom,—it ſwept him away. Soon after this, the enemy went up the river, and purſued the boat which had the ſub-marine veſſel on board—and ſunk it with their ſhot. Though I afterwards recovered the veſſel, I found it impoſſible, at that time, to proſecute the deſign any farther. I had been in a bad ſtate of health, from the beginning of my undertaking, and was now very unwell; the ſituation of public affairs was ſuch, that I deſpaired of obtaining the public attention, and the aſſiſtance neceſſary. I was unable to ſupport myſelf, and the perſons I muſt have employed, had I proceeded. Beſides, I found it abſolutely neceſſary, that the operators ſhould acquire more ſkill in the management of the veſſel, before I could expect ſucceſs; which would have taken up ſome time, and made no ſmall additional expence. I therefore gave over the purſuit for that time, and waited for a more favourable opportunity, which never arrived.

Other Experiments made with a Deſign to fire Shipping.

In the year 1777, I made an attempt from a whale-boat againſt the Cerberus frigate, then lying at anchor between Connecticut river and New London, by drawing a machine againſt her ſide, by means of a line. The machine was loaded with powder, to be exploded by a gun-lock, which was to be unpinioned by an apparatus, to be turned by being brought along-ſide of the frigate. This machine fell in with a ſchooner at

 anchor,

anchor, aſtern of the frigate, and concealed from my ſight. By ſome means or other it was fired, and demoliſhed the ſchooner and three men — and blew the only one left alive over-board, who was taken up very much hurt.

After this I fixed ſeveral kegs under water, charged with powder, to explode, upon touching any thing, as they floated along with the tide: I ſet them afloat in the Delaware, above the Engliſh ſhipping at Philadelphia, in December, 1777. I was unacquainted with the river, and obliged to depend upon a gentleman very imperfectly acquainted with that part of it, as I afterwards found. We went as near the ſhipping as he durſt venture; I believe the darkneſs of the night greatly deceived him, as it did me. We ſet them adrift, to fall with the ebb, upon the ſhipping. Had we been within ſixty rods I believe they muſt have fallen in with them immediately, as I deſigned; but, as I afterwards found, they were ſet adrift much too far diſtant, and did not arrive until after being detained ſome time by froſt, they advanced in the day-time, in a diſperſed ſituation, and under great diſadvantages. One of them blew up a boat with ſeveral perſons in it, who imprudently handled it too freely, and thus gave the Britiſh that alarm which brought on *the battle of the Kegs.*

LXVI. *Experiments and Obſervations on Land and Sea Air.* By ADAM SEYBERT, *M. D.*

From the TRANSACTIONS of the AMERICAN PHILOSOPHICAL SOCIETY.

AN endeavour to add any facts or obſervations to a branch of knowledge, which has been treated of by many of the moſt enlightened philoſophers of the preſent century, may be deemed a hazardous attempt. But although we have many accounts of eudiometrical experiments by Prieſtley, Fontana, Ingenhouſz, and others; the ſubject is not exhauſted, and an extenſive field continues open for him who wiſhes to engage in this intricate branch of Pneumatic Philoſophy.

The purity of the air is not intereſting to us merely as an object of curioſity, but demands our attention as phyſicians and philoſophers. In proportion to the number of aſcertained facts, the certainty of inference is increaſed. The ſhort life of any one individual, together with his local ſituation, will prevent him from completing this department of ſcience. It is merely from repeated experiments, made under different circumſtances, that we can expect to arrive at truth. The more we multiply facts, the more decided may we be in our concluſions. Such are the reflections which induced me to engage in a ſeries of experiments, which ſhall be related in the following pages.

Our

Our atmoſphere having been ſo ſucceſsfully analyzed by the celebrated Lavoiſier, and being found to conſiſt of fluids poſſeſſing very different and oppoſite qualities; chemiſts ſoon began to enquire whether its ingredients might not be in various proportions in different ſituations; and, particularly, whether it differed in point of purity in different ſituations on land and on the ocean.

Moſt of the experiments, of which we have an account, were made on land: the Memoir of Dr. Ingenhouſz, publiſhed in the ſeventieth volume of the Philoſophical Tranſactions, is the only eſſay I have ſeen containing experiments made at ſea: but his traverſe was ſo ſhort, that he had not an opportunity of examining the air in different latitudes. He, however, is of opinion, that ſea air is, *cæteris paribus*, purer than land air; but he appears to have found ſome ſeeming contradictions of his general inference. He ſays, page 364, that air, taken from the middle of the channel, was of an inferior quality to that at the mouth of the Thames; and that air near the ſea-ſhore at Oſtend was nearly as good as that at the mouth of that river. Although we may, to a great degree, adopt his ſentiments, nevertheleſs I think it probable, that this increaſed purity does not entirely depend upon the ocean; for I have found the air over the Bays at Cheſapeak and Delaware of the ſame degree of purity with the atmoſphere of the ocean. And hence I am inclined to think, that the air over a large body of water is always purer, *cæteris paribus*, than that of the adjoining land, owing perhaps to a decompoſition which the water may ſuffer from the action of the

the ſun's rays; and this may likewiſe be aſſiſted by its alſo abſorbing many foreign matters which on land are more or leſs intimately mixed with the air in a mechanical way. This opinion is confirmed by Dr. White's experiments, who ſays, "the air over the river Ouze was conſtantly purer than that of the garden by two or three degrees." Philoſophical Tranſactions, vol. LXVIII. —And in the ſame paper he obſerves, that the ſame happened with the air of the foſs when the marſhes were overflowed.

When I firſt engaged in theſe experiments it was my intention to perform them only on ſea air; but I ſoon found it neceſſary to repeat them on land air for the ſake of compariſon. The ſubject increaſed on my hands. The atmoſphere of marſhes preſented itſelf as worthy of ſerious inveſtigation. I therefore performed ſome experiments upon it; but proper length of time is neceſſary to their repetition; and for this reaſon I muſt omit them for the preſent, and merely relate thoſe I performed on the air of this city, its environs, and on the ocean.

I ſhall firſt proceed to the enquiry, whether the atmoſphere differs in purity in different ſituations on land?

The opinion that the air is purer in the country and on the tops of mountains than it is in towns, is adopted by many; therefore, in aſſerting the contrary, we muſt prepare to meet with oppoſition, particularly from thoſe who have formed opinions from reaſoning alone, unſupported by experiments. In doubtful matters it is chiefly by the claſhing of opinion that truth is finally diſcovered. This ſhall be both my conſolation and apology, if the reſult of my experiments ſhall be found

found to have induced me to differ from others. Nevertheleſs, it will afford me conſiderable ſatiſfaction to agree with thoſe whoſe deciſions reſt upon the ſame firm baſis. I ſhall, therefore, briefly mention the authors who agree with me in opinion.

Dr. Prieſtley concludes from his own experiments, that the difference of the air in different places, ſuch as is indicated by a mixture of nitrous air, is in general very inconſiderable. He mentions that the air of Harthill, near Mancheſter, and that of Wiltſhire, were about the ſame.

The compilers of the Encyclopædia ſay, "that the general maſs remains, upon all occaſions, pretty much the ſame." And Scheele is much of the ſame opinion.

But the accurate Fontana ſpeaks with more confidence, and is more explicit. His aſſertions are founded upon the reſult of many experiments; and he is inclined to believe, that the ſlight variations, mentioned by ſome philoſophers, are rather to be attributed "to the fallacious effects of uncertain methods," than to any real difference in the air itſelf. He found the air of Iſlington and London to ſuffer an equal diminution from the mixture with nitrous air. The air taken at different heights in London and Paris did not differ in purity. Air, at the height of 313 and 202 feet, in London, differed ſcarcely at all; and no difference was perceptible between the air of theſe heights and that of the ſtreet adjoining.

The more I reflect on this ſubject, the more I am inclined to adopt the following ſentiment of this laſt-mentioned gentleman; *viz.* "The difference of the purity of the air, at different times, is

is much greater than the difference between the air of the different places." Indeed moſt of the experiments related by Dr. Ingenhouſz alſo tend to confirm it. In general, the difference in the air of different places at the ſame time was by no means conſiderable.

I ſhall now with more confidence relate the experiments I myſelf performed: but, previous to this recital, I ſhall give a brief account of the method I purſued.

It is neceſſary to remark, that every experiment I ſhall relate is the reſult of at leaſt two different trials.

Moſt authors who have engaged in this ſubject uſed eudiometers of a different conſtruction; I adopted the moſt ſimple as the beſt. Thoſe who deſire a particular deſcription of theſe inſtruments may be ſatisfied by referring to the Encyclopædia and different parts of Dr. Prieſtley's Treatiſe on Air. Mine is as follows*:

I had a glaſs tube, about fourteen inches in length, and in diameter nearly half an inch, provided with a graduated ſcale, made ſo as to ſlide upon the tube up or down, as occaſion required.

* The atmoſphere is proved, by inconteſtable experiments, to conſiſt in general of

Oxygen gas	0.27
Azotic gas	0.72 and
Carbonic acid	0.01

It is a fact, well known to chemiſts, that nitrous air will combine with oxygen gas, and form a compound, *viz.* the nitric acid. As theſe two gaſes combine, they aſſume a ſtate approaching nearer to that of a ſolid, and conſequently occupy leſs ſpace than they did before their union. Upon this diminution of bulk depends our eſtimation of the purity of the air. The greater the contraction, the purer we ſuppoſe the air under trial.

 This

This ſcale was divided into one hundred equal parts.

My meaſure was a ſmall ſmelling bottle, containing ℥j. and gr. xvj. of clear pump water. The ſpace, occupied in the tube by a bulk of air which this meaſured could contain, was equal to the hundred diviſions of the graduated ſcale.

My water trough on-board of the ſhip was the common water bucket; on ſhore it was a common houſe bucket or tub.

The nitrous gas was prepared from diluted nitric acid and braſs filings.

At ſea I uſed ſea water in the trough; on land common pump water: for, from different trials made by Dr. Ingenhouſz, it is evident this circumſtance could not produce a variation in the reſult of the experiments.

My method of operating is as follows: after having introduced two meaſures of the air, whoſe purity I deſired to aſcertain, into the glaſs tube, I introduce one meaſure of nitrous gas; then, ſuffering the tube to remain undiſturbed for about a minute, I noted down how far the water aſcended without agitation; this is what I have called, upon mixture: I then agitated the tube three ſucceſſive times, after the manner of M. de Sauſſure, and noted how high the water roſe. In many inſtances I added a ſecond meaſure of nitrous gas, and thereby completely ſaturated the air under examination.

I was particularly cautious of avoiding miſtakes from hurry or inattention, and took ſome pains to guard againſt all the circumſtances Dr. Ingenhouſz mentions as liable to produce a variation in the reſult of experiments of this kind.

My

My firſt experiment on land air was performed Auguſt 2, 1796. Two meaſures of air in the yard of my lodging, when mixed with one meaſure of nitrous air, left upon mixture 2.48 of a meaſure; and after ſhaking the tube 1.79. I then added another meaſure of nitrous air and 2.65 remained.

I then ſubmitted air to the teſt of the eudiometer, which I had previouſly collected in different ſtreets of this city, *viz.* in Water between Market and Arch Streets; in Spruce near Fourth Street; in Cheſnut near Fifth; and, in Market between Second and Third Streets. Each of theſe airs gave nearly the ſame reſult, and generally agreed with that of the air of the yard of my lodging: none of the experiments ſhew a difference of 0.02 of a meaſure.

Similar experiments I have ſince repeated, and the reſult was the ſame.

Auguſt 3. I collected air on the top of the hill whereupon Dr. Smith's obſervatory ſtands at the Falls of Schuylkill, five miles from Philadelphia. In another phial I received air from above the middle of the road directly at the foot of the hill. And immediately on my return home I ſubmitted them and the air of the yard to experiment, and found them to agree exactly as follows:

Upon mixture 2.48

After ſhaking the tube 1.78, and upon adding a ſecond meaſure of nitrous air, 2.63 remained.

Auguſt 5. I collected air from above two different marſhy ſituations immediately below the rope-walks to the ſouth of this city. It is of conſequence to remark, that theſe marſhes are over-

 flowed

flowed by the tide. Another phial I filled immediately before entering the city in Front Street. Theſe airs ſuffered an equal diminution from a mixture of nitrous gas, *viz.* 2.47 upon mixture; after ſhaking the tube 1.79; and after adding a ſecond meaſure of nitrous gas 2.64 remained.

The air near my lodging yielded upon mixture 2.49; after ſhaking the tube 1.78; and upon the addition of a ſecond meaſure of nitrous gas 2.62.

I performed ſome experiments on air collected in other ſituations about the city; but, finding the reſult ſo much the ſame as thoſe above related, I did not make any note of them, and remain perfectly ſatisfied that Fontana's aſſertion is well founded.

The experiments I performed on the River Elk and Bay of Cheſapeak perfectly agree with each other; and the reſult was the ſame with thoſe performed on the 7th of July, &c. as mentioned in the table. The wind blew from the North, and the ſky was partially cloudy. They were performed in Auguſt laſt.

Experiments, which I made at ſea, ſufficiently prove that the atmoſphere is conſiderably purer there than it is on land. Though there are ſome trifling differences in the reſults of ſeveral experiments, I have no reaſon to believe that they were owing to the different ſituation in point of latitude or longitude in which they were performed. I can form no ſyſtem reſpecting ſuch variations. Winds, temperature, rain, &c. do not ſeem to have produced them. As they did not obſerve any regularity in their occurrence, they may perhaps be attributed to certain unperceived

ceived errors, which are unavoidably attendant on ſuch trials.

That the air at ſea ſhould appear nearly of the ſame purity in different latitudes does by no means aſtoniſh me; for if land air has certain matters mixed with it, they are *perhaps* abſorbed; and if my ſuppoſition be true, that the influence of the ſun's rays on the water tends to increaſe its purity, the opinion I entertain is not ſurpriſing. For when once purified, there are perhaps none, or few cauſes to render the air noxious after it is wafted from our towns and cities over a large body of water.

It occurred to me, that probably the purity of the air at ſea varied at different periods of the day: to ſatisfy myſelf on this point, I made ſeral trials on the 10th and 17th of June laſt. On the 10th I performed them at 9 o'clock A. M. at 12, and at 6 o'clock P. M. On the 17th at 9 A. M. and at 12 o'clock. The reſult of all the experiments of the ſame day was exactly ſimilar, at leaſt not perceptibly different.

Whether or not ſea air might be rendered more pure by agitation with water, appeared to me to be a queſtion worthy of being aſcertained. Particularly as ſome celebrated men reaſon that it has this effect, and muſt hence be looked upon as one of the greateſt reſources which we have for purifying the atmoſphere. Sir John Pringle and Dr. Ingenhouſz are of this opinion. But ſome of Dr. Prieſtley's experiments ſeem to contradict it; and ſo does the following aſſertion of the celebrated Scheele, who ſays, " L'air ne s'unit pas avec l'eau commune." Traité de l'air and du feu, p. 51.

My

My experiments on this head are as follow: on the 26th and 28th of June, the 2d and 5th of July, equal bulks of ſea water and air were agitated for half an hour in my eudiometer tube; but I never diſcovered any abſorption to have taken place; neither was the air rendered purer, as was evident from a mixture with nitrous air.

It now appeared probable to me, that ſea water was already ſaturated with all the gaſeous particles it could abſorb; and that freſh water when agitated with ſea air might diminiſh its bulk, or alter its purity. In conſequence of this ſuppoſition, equal bulks of ſea air and freſh water were agitated as above; but it was not in the leaſt altered. Not entirely ſatisfied of the fallacy of my conjecture, I boiled ſea water a ſufficient time to purge it of the air it might contain. I then agitated ſea air with this boiled water, as above mentioned, and found no difference in reſult from the other experiments. Theſe reſults tend to confirm me in my belief, that if ſea water purifies the air, it is rather by adding a ſomewhat than by abſorbing any conſiderable quantity of effluvia floating therein. Though by this I do not mean to ſay, that certain matters, foreign to our atmoſphere, do not float therein on land. If they exiſt, perhaps they may be ſubject to abſorption by water.

LXVII.

LXVII. *Procefs for extracting Sugar from Honey. By Citizen* CAVEZZALI.—*Extracted from a Letter of Citizen* DUBURQUA, *Druggift at Lodi.*

FROM THE *ANNALES DE CHIMIE.*

HAVING confidered that honey being a mixture of fugar and mucilage, it would be poffible to extract the fugar, Citizen Cavezzali made an extract of honey by means of carbon, but without fuccefs; for he obferved that the honey after fome time became fluid; that it whitened and polifhed metal; that, in purifying it, its vapour attacked the wind-pipe; hence he concluded, that it contained an acid, which he juftly confidered to be the obftacle that prevented the cryftallization of the fugar.

He took a quantity of white honey, which he placed in a gentle heat, in an earthen veffel; he afterwards fcummed it, ftrained it, and placed it again, in the fame veffel, over a furnace, very moderately heated. He then added pulverized egg-fhells to the honey, upon which a very marked effervefcence took place; he continued to add this powder till the faturation was complete; he then removed the veffel from the fire, and left it to ftand in a quiet place for fome time.

A very denfe froth afterwards formed itfelf upon the furface. Some flakes of mucous matter floated in the liquor, which he ftrained till it became limpid; and he obtained a real fyrup of fugar, deprived of the poignant properties of the honey. This fyrup he divided into two parts: one-

one-half he put into a bottle, and, with the other, he formed a liquor, which was judged to have been sweetened with sugar. The experiment was repeated several times, and always with the same result.

Four months after, he examined the bottle that contained the syrup: he found the bottom covered with crystals; upon which he broke the bottle, collected the crystals, and collected the sugar, which he put to dry. It attracted humidity from the atmosphere, and it appeared of a reddish colour. He deprived it of this colour, by washing it with alcohol; after which it no longer attracted humidity.

In performing these operations, the following circumstances are to be attended to. 1. The honey should be white and pure. 2. It ought to be clarified with the white of egg. 3. The vessels ought to be earthen-ware, but never of metal, for these are bad conductors of caloric. 4. Only the bottom of the vessel should be exposed to the fire, in order that the heat may not attack the mucous substance. 5. It ought to be placed quite hot, after it has melted, upon a furnace. 6. The addition of the powder of egg-shells must be performed gradually, lest it should become clotted into lumps. 7. When the saturation is accomplished, the vessel should be removed from the fire, and the liquor left to stand quiet for the space of a day. 8. The liquors must be scummed, washed, filtrated, mixed, and evaporated, to the proper consistence.

LXVIII. *Description of an Improvement in* Woulfe's *Apparatus.* *By Mr.* Girard.

WITH A PLATE.

From Scherer's Journal of Chemistry.

Woulfe's ingenious apparatus, which has been found so very useful in modern chemistry, is always attended with some inconvenience in its application. It had long been endeavoured to give it a more simple construction; and, in fact, some methods have been contrived for keeping this apparatus hermetically closed, without luting; but they are, upon the whole, too difficult in the execution. The apparatus which we shall here propose may be put together and taken asunder within a few seconds, and is applicable under all circumstances.

We get bottles made in a glass-house, the one tubulature of which, A, (Plate XIX.) Fig. 1, has in the inside a tube A B, which is soldered to it by means of a glass ring. The opposite tubulature is at first drawn pointed, or into a thin tube, as usual; but we do not afterwards break off this tube, in order to spare the tubulature, close to the bottle, but leave it entire, and bend it in such a manner, that it terminates in an arch of a circle, which enters the tube A B. It is scarcely necessary to mention, that the tube A B, and the beak which is to be inserted into it, must have the same curvature. This may easily be obtained by bending them both over the same cylinder of earth or wood.

 It

It is very evident, that when the beak of the one bottle is fitted into the tube of the other, so that the end of the beak projects beyond the lower extremity of the tube, and the tubes within stand under water, the gas cannot escape out of one bottle in any other manner than by passing through the beak, and ascending in the other, in bubbles, through the fluid with which it is filled.

Fig. 2, represents another construction of Woulfe's apparatus, which may supply the place of the former, in want of a glass-house. It is composed of tubulated bottles, with wide necks. We take a pretty thick tube, which must have an orifice wide enough for another to be inserted through it; at the upper part of this we leave a bulb, which must fit exactly into the neck of the bottle, so as to close it like a cork.

We then take another tube, which passes through the first, and can be freely moved within it. The one end A is formed as before, so as to fit into the tubulature of another bottle; we then give it the usual curvature, A B C. Finally, we insert it through the former tube, Fig. 3, E F, and bend its projecting end D upwards. Fig. 2, shews the manner in which this apparatus is put together; and it is evident, that it is hermetically closed, as soon as the lower extremity of the thicker tube stands under water.

The tubes and beaks are bent, merely in order that the air-bubbles that arise may receive the proper direction, and not be able to escape through the thicker tube. When, therefore, the apparatus is sufficiently large for the beak to project an inch or more, it is unnecessary to bend it, as it is already impossible for the air to get into the

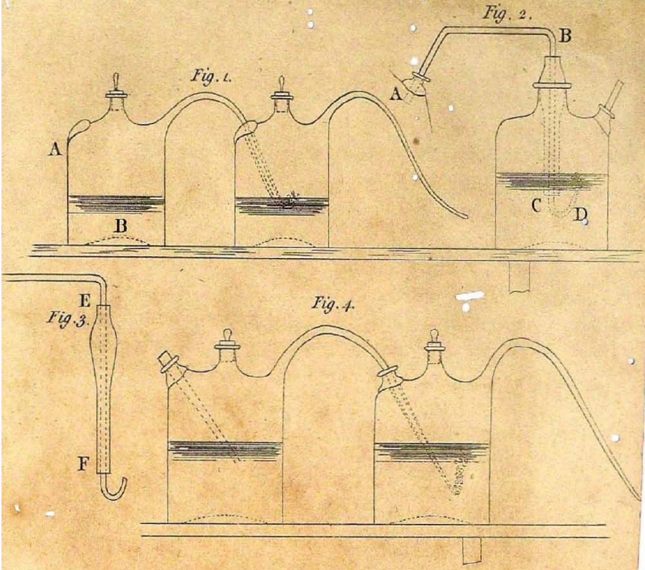
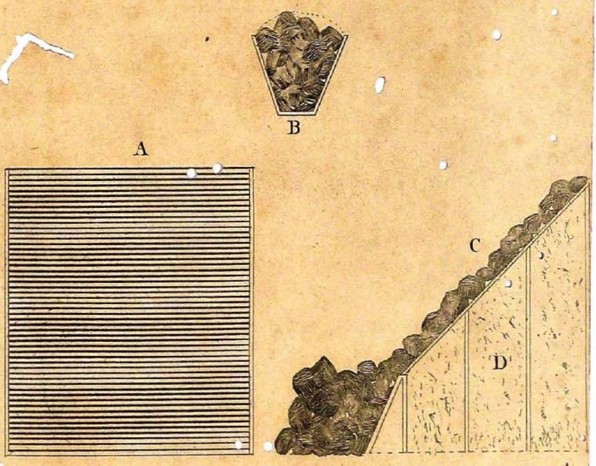


Fig. 1.
A
B
Fig. 2.
A
B
C
D
Fig. 3.
E
F
Fig. 4.


B
A
C
D

the thicker tube. Fig. 4, repreſents another contrivance.

When we have to employ an apparatus, conſiſting of a very long row of bottles, there is reaſon to apprehend that the gas in the firſt veſſel, which has a great degree of reſiſtance to ſurmount, may force the water of the firſt bottle into the tube, and compel it to flow out; but this inconvenience may eaſily be obviated, either by employing bottles of different ſizes, or putting leſs water into the firſt bottles than into the ſubſequent ones.

LXIX. *Memoir on a Method of Painting with Milk. By* ANTOINE-ALEXIS CADET-DE-VAUX, *Member of the Academical Society of Sciences, &c.*

FROM THE *DICADE PHILOSOPHIQUE, &c.*

I PUBLISHED, in the "Feuille de Cultivateur," but at a time when the thoughts of every one were abſorbed by the public misfortunes, a ſingular œconomical proceſs for painting, which the want of materials induced me to ſubſtitute inſtead of painting in diſtemper.

One of my neighbours had been repairing his country-houſe, in which he had employed ſome old pieces of timber, which, on account of their ugly colour, required to be painted; but the general want of every article, and eſpecially of money, (this was at the time of the maximum and aſſignats,) did not allow him to go to ſo great an

 expence;

expence; for the price of the colour alone would have amounted to 400 francs. He therefore thought fit to conſult me, and it was fortunate he did ſo. At the time he came to converſe with me, I was employed in painting a hot-houſe in my garden. He found me painting without diſtemper, and without oil; he ſpoke of the expence of 400 francs; but I ſoon removed his uneaſineſs, by telling him that I would reduce the ſum to a tenth part. Part of the hot-houſe had been painted in the morning; he tried this firſt layer by rubbing it with the palm of his hand; but I deſired him to rub it with his great coat, which was made of ſhag-cloth. It reſiſted the friction like varniſh. He requeſted to know my ſecret, and as I make no ſecret of any thing of this kind, but rather wiſh to make known whatever can be of uſe in the different branches of œconomy, I acquainted him with my proceſs.

As I am not very dexterous in managing the bruſh, I ſent, on the day after I had made this trial, for a painter from Franconville, to paint the cieling and floor of my library.

As my paint ſmelt neither of ſize nor of oil, the painter told me it was a miſerable waſh, and thought himſelf very complaiſant in condeſcending to uſe it. I had taken care not to ſhew him the reſult of my firſt trial with it. He began with the cieling. I gave him another pot of yellow colour for the floor. Whilſt the floor was painting the cieling had dried, ſo that he had an opportunity of judging of the ſolidity of this method of painting. He acknowledged its ſuperiority over the method of painting in diſtemper, of which a ſingle, and even ſeveral coats, cannot bear to be rubbed with a coarſe cloth without

coming

coming off. He ſeemed ſtruck with aſtoniſhment, apologiſed, and concluded by requeſting to know my ſecret. I told it him; and he has ſince turned it to good account.

At the preſent moment I am about to paint again; or rather I am about to make a new experiment, in order to eſtabliſh the proceſs for this method of painting, but particularly for ſubſtituting it in the place of oil-painting.

To proceed to the method itſelf:

Take ſkimmed milk, one pint (or two Paris pints).

Freſh ſlaked lime, ſix ounces.

Oil of carraway, or linſeed, or nut, four ounces.

Spaniſh white, five pounds.

Put the lime into a veſſel of ſtone-ware, and pour upon it a ſufficient quantity of milk to make a ſmooth mixture; then add the oil by degrees, ſtirring the mixture with a ſmall wooden ſpatula; then add the remainder of the milk, and, finally, the Spaniſh white. Skimmed milk in ſummer is often curdled, but this is of no conſequence to our purpoſe, as its fluidity is ſoon reſtored by its contact with the lime. It is, however, abſolutely neceſſary that it ſhould not be ſour, for in that caſe it would form with the lime a kind of calcareous acetite, ſuſceptible of attracting moiſture.

The lime is ſlaked by plunging it in water, drawing it out, and leaving it to fall to pieces in the air.

It is indifferent which of the three oils abovementioned we uſe; however, for painting white, the oil of carraways is to be preferred, as it is colourleſs. For painting with the ochres the commoneſt lamp-oil may be uſed.

The

The oil, when mixed with the milk and lime, difappears, being entirely diffolved by the lime, with which it forms a calcareous foap.

The Spanifh white muft be crumbled, and gently fpread upon the furface of the liquid, which it gradually imbibes, and at laft finks; it muft then be ftirred with a ftick. This paint is coloured like diftemper, with charcoal levigated in water, yellow ochre, &c.

It is ufed in the fame manner as diftemper.

The quantity above mentioned is fufficient for painting the firft layer of fix toifes.

The price of this quantity amounts to 9 fols, which reduces the price of the toife to 1 fol 6 deniers, prime coft.

The procefs that has been given is fufficient for the moft of thofe who ufe this method of painting; but let us reafon upon it, and confider the theory which has directed me in the choice and combination of thefe ingredients.

Firft, let us fpeak of painting in diftemper. This is done, as is well known, with fize, mixed with Spanifh white or ochre.

Let us now confider its inconveniences, which are numerous.

The firft is, that it comes off by the flighteft friction, fo that when it is ufed for ftair-cafes and paffages one is obliged to be upon one's guard againft fuffering the clothes to come in contact with it.

It is true that this inconvenience may be remedied by making the fize ftronger, and laying on a greater number of coatings; but when this is done, the painting, in the courfe of time, and in dry fituations, cracks, and comes off of itfelf.

Befides,

Beſides, three layers of diſtemper will coſt 1 livre 10 ſous.

What happens with this painting when the ſeaſon, or the ſituation, is moiſt? The ſize, which forms the baſis of diſtemper, grows moiſt, and ferments; like every other gelatinous animal ſubſtance it rapidly paſſes, by fermentation, into the ſtate of acidity; it then loſes its gelatinous conſiſtence, and ceaſes to be glue; it becomes water, poſſeſſing fluidity and acidity, and ſpeedily paſſes into the ſtate of putrefaction. It is particularly at the time of thaw that this effect of moiſture becomes very apparent; we then ſee the diſtemper to run down in ſtreaks along the walls and wood-work. The earth or ochre, formerly ſuſpended in this gelatinous ſubſtance, are then left ſeparate in their pulverulent ſtate, and the paint falls off.

This diſpoſition of glue, to attract humidity from the air, and to ferment, explains the reaſon why diſtemper for ſome time emits a ſmell, at leaſt unleſs it be varniſhed, which in ſome degree remedies theſe inconveniences; but then it increaſes the expence.

It is alſo to be remarked, that the preparation of diſtemper requires a fire, and we muſt alſo pay the workmen for the part of the morning which they employ in preparing it. Finally, this paint will not keep; it frequently paſſes into fermentation in the courſe of twenty-four hours, particularly in ſtormy weather.

Let us now compare our method of painting with the method in diſtemper.

Skimmed milk has loſt its butyraceous part, but it retains its cheeſy part, of which milk contains more or leſs; we may reckon the proportion

tion at about one-fourth, in the ſtate of a ſtrong jelly; conſequently there is about one-fourth in the Paris pint, or four pounds of milk, which is our proportion. I ſay in the ſtate of jelly; for the caſeous part, not being ſoluble in water, is not jelly, but glue.

We have therefore one pound of glue, which deſerves the name of *ſtrong glue*, to diſtinguiſh it from the glue, commonly ſo called, which is appropriated to give body to colours; but this glue of milk has great advantages over that animal glue.

The caſeous part retains a portion of moiſture, which is the principle that gives it elaſticity. Take, for example, the cheeſe of Gruyères; be it ever ſo dry, it is always elaſtic; it may be grated, but it cannot be pulveriſed.

This portion of moiſture, which the cheeſy part retains, is ſufficient for its compoſition; it therefore does not attract moiſture from the atmoſphere, ſo that the paint, of which it conſtitutes the baſe, does not crumble in dry, elevated, and well-aired ſituations, neither does it become ſoft in low and damp places.

One of the properties of my paint, which we may term *milk-diſtemper paint*, (*Peinture au lait detrempe*,) is, that it will keep for whole months, and requires neither time nor fire, nor even manipulation; in ten minutes we may prepare enough of it to paint a whole houſe. Poſſibly there is alſo formed in this mixture a combination, namely that of the Spaniſh white with the oil, which in that caſe would add greatly to the ſolidity of the painting. Glazier's putty, which is ſo ſolid that it becomes almoſt impoſſible to detach it, is nothing more than this mixture,

and

and ſo is alſo the lute employed by chemiſts. It is therefore evident how much this putty muſt add to the ſolidity of a colour that contains it in ſolution.

This advantage is alſo attended with other very great conveniences. One may ſleep in a chamber the night after it has been painted, for the milk-diſtemper-paint dries in the ſpace of an hour, and the oil which enters into its compoſition loſes its ſmell and character of oil by its combination with the lime, which converts it into a true ſoap; the ſmell of this colour, when freſh laid on, is like that of a ſoap-ley, or like that of a place in which linen is bleached.

A ſingle coating is ſufficient for places that have already been painted. It is not necſſary to lay on two, unleſs where greaſe ſpots repel the firſt coating; theſe ſhould be removed by waſhing them with ſtrong lime water, or a ley of ſoap, or ſcraped off.

New wood requires two coatings. One coating is ſufficient for a ſtair-caſe, paſſage, or cieling.

The hot-houſe which I mentioned has its door hung within; the embraſure is therefore expoſed to all the injuries of the weather, notwithſtanding which, and the continual friction, the ſtreaks of the bruſh are ſtill viſible, and the paint has not undergone the ſmalleſt alteration.

I have ſince given a far greater degree of ſolidity to this method of painting, for it has been my aim, not only to ſubſtitute it in the place of painting in diſtemper, but alſo of oil-paint.

Resinous Milk-painting.

For work out of doors, I add to the proportions of the milk-distemper-painting,

Slaked lime, ...	2 ounces.
Oil, ...	2 ounces.
White Burgundy pitch, .	2 ounces.

The pitch is to be melted in the oil by a gentle heat, and added to the smooth mixture of milk and oil. In cold weather the mixture ought to be warmed, to prevent its cooling the pitch too suddenly, and to facilitate its union with the milk of lime. This painting has some analogy with that known by the name of encaustic.

I have employed the resinous milk-paint for outside window-shutters, that had previously been painted with oil.

Oil-painting, which is considered to be so durable, is subject to many of the inconveniences of painting in distemper; that is to say, it shrinks, cracks, scales off, and separates, only with this difference, that the scales adhere at some points; but it is no less true that the wood remains bare, and consequently exposed to the injuries of the air.

It will be proper, in order to give the painting a neater appearance, to rub the surface with sand-stone or pumice-stone, before the first coating is laid on.

Time, which destroys every thing, will destroy this painting; but I see no reason in theory, why the adhesion of resinous milk-painting should break, or why it should crack or scale off like oil-painting, the base of which is ceruse, a preparation of lead, which renders the oil drying, and

and diſpoſes this kind of painting to ſcale off. This metallic ſubſtance has beſides the inconvenience of becoming coloured in the air by the action of the hydrogen gas; the white paint becomes yellow, and frequently even is covered with black ſpots, produced by a new oxydation, which takes place in the oxyd of lead. The exhalations of a drain, privy, or dunghill, are ſufficient completely to blacken oil-painting.

There is no lead in the compoſition of reſinous milk-painting; ſo that this inconvenience is not to be apprehended. The air cannot change the colour of this painting, as I am convinced from what I have ſeen in my hot-houſe; and every hot-houſe is expoſed to the effluvia of dung.

I need not mention the diſagreeable ſmell of oil-painting, nor its permanency; it is found, eſpecially in country-houſes that are not inhabited during the winter, to continue for ſeveral years ſucceſſively.

The dangerous effects of the effluvia of oil-paint are frequent and well known.

The reſinous milk-painting, notwithſtanding the Burgundy pitch and oil that enters into its compoſitions, emits no ſmell but that of turpentine *; a ſmell which is eaſily diſſipated; beſides which it is only uſed for out-door work.

Of Badigeon †.

There are ſtill ſtronger reaſons for ſubſtituting either of the above-mentioned methods of

* It is well known that Burgundy pitch is the reſiduum of the diſtillation of turpentine with water, an operation which is performed for the purpoſe of ſeparating the oil, which is known in commerce by the name of Eſſence of Turpentine.

† We have no Engliſh term for this paint.

painting inftead of that which is termed *badigeon.*

Badigeon confifts of quick-lime, yellow-ochre, and water; it keeps very well within doors, but it has no durability at all when expofed to the air. The mixture has no confiftence, and its adhefion to ftone is fo weak, that the rain carries it away, fo that after two or three years not a trace of it remains.

Befides, this mode of painting cofts 10 fols the toife; whilft, as has before been obferved, the milk-diftemper painting does not coft more than 1 fol 6 deniers, prime coft; to which we muft add the price of laying it on, which however does not amount to much, as one man may paint a great number of toifes in a day.

But I fhould prefer painting with the refinous milk-compofition, ufing the lime and yellow-ochre, either with or without the addition of Spanifh white. This paint would laft twenty or thirty years without alteration: I know of nothing that could injure it except the nitrification of the walls, and this is a flow procefs.

I have faid much againft painting in diftemper and in oil, and have pleaded the caufe of thofe methods which I propofe; but the theory by which I have been guided in preparing my pigments, and the trials which I have made of them, will fpeak ftill more ftrongly in their favour.

I can fee only one objection; namely, the difficulty of procuring the requifite milk.

To this I reply: there is more want of buyers for milk, than milk for buyers. In the fruit-feafon, the venders of milk find no fale for the article; they therefore make indifferent cheefe and butter of it, as few of them know how to make

make either of them good. The ſale of theſe two articles is far leſs lucrative than that of milk, which they prefer to ſell in its natural ſtate. The ſummer is alſo the ſeaſon for painting. The conſumption of milk for painting would ſupply the deficiency of its conſumption as aliment; beſides, if four times the quantity of milk were conſumed at Paris, the country would furniſh it; for, beſides the profit upon the ſale of the milk, there is that of the dung, which is ſold at a high price to the farmer. Should it be neceſſary to procure the milk from a diſtant place, let it be mixed at the place itſelf with half the proportion of lime; it may then be tranſported without turning ſour or curdling, and we ſhall receive it in a proper condition for the uſe we intend to make of it. In the country, and in the provinces, no one will mention the ſcarcity of milk as an objection.

I therefore invite thoſe chemiſts who devote themſelves to the improvement of the arts, to attend to this method of painting, to fix the proportions of the ingredients, to aſcertain whether lime acts upon the ochres or colouring oxyds, and, finally, by perfecting the proceſs to render it as uſeful as I hope it may become. From this union of effort would reſult a ſimplication of this ſo uſeful branch of the arts, a great ſaving for individuals, greater cleanlineſs, and neatneſs in our habitations, and, above all, greater ſalubrity; for nothing alters the purity of the air more than oil-painting.

LXX. *Method of preventing and deſtroying the mephitic Taint with which Walls become impregnated where a Number of Perſons, particularly Sick, are collected together. By the Author of the preceding Paper.*

FROM THE *DECADE PHILOSOPHIQUE, &c.*

IN my memoir on milk-painting, I had conſidered it only as an object of domeſtic œconomy, ſo that I neglected to treat of the uſeful application of this method of painting to the demephetiſation of walls. Let me therefore ſupply the omiſſion.

Wherever a great number of perſons, either healthy or ſick, are collected together, the walls are penetrated, and become inſenſibly ſurcharged with infectious effluvia, which they again exhale in conſequence of the motions of the atmoſpherical air; ſo that actual inhalation and exhalation take place in them. The currents of air which are conducted through ſuch places ſerve very well to renovate the atmoſphere, but they do not carry away with them the miaſmata that lurk in the pores of the walls, and which are retained there by the infectious moiſture proceeding from the perſpiration of the bodies, and which condenſes itſelf upon their ſurface.

I have mentioned inhalation and exhalation: in fact, in the ſouthern climates, and particularly in Italy, where the phthiſis aſſumes a character of energy that renders it very contagious, experience has ſhewn that it is neceſſary, not only to burn all the clothes and furniture that have been

in

in contact with the phthisical person, but likewise to remove the superficial layer of the walls and floors, in order to prevent the contagious miasma, which is concealed in them, and which they re-exhale, from taking effect. In my opinion, quick-lime might be substituted in the place of these means, and prove a sufficient preventative of the contagion, as it has powerful demephitisating properties

By washing with water and lime I entirely deprived a dead body, in a state of putrefaction, which I was charged, by a decree of the parliament, to have dug out of the ground, of its smell, on account of the dangers that might arise from digging it out of ground.

This mephitism is so inherent, that even time cannot dissipate it, as was proved by the example of the Donjeon of Vincennes, when it ceased to be a state prison, under the administration of Malesherbes. Curiosity attracted a great concourse of people to the dungeon; and those who had formerly inhabited the prison being particularly curious to see it, they recognised the same smell in it with which they had been struck upon entering it the first time; and yet the doors and windows had been removed, and the elevation of the building exposed it to the free action of the air.

Workshops, manufactories, infirmaries, hospitals, prisons, and all such buildings, have an atmosphere peculiar to themselves, an atmosphere which shortens the lives of the individuals, or often becomes the source of epidemic, and sometimes pestilential maladies, as the hospital or prison fever, &c. Plants, when deprived of air, languish

languish and lose their colour; the effects of this privation must be still more powerful upon animals, whose lungs consume so large a quantity of air.

Citizen Guyton-de-Morveau has discovered a method, by means of muriatic, or preferably oxygenated muriatic gas, of purifying any atmosphere impregnated with contagious and pestilential miasmata. It washes such an atmosphere, and deprives it of its miasmata, which it seizes upon and destroys. This important discovery gives Citizen Morveau a claim to the title of one of the benefactors of humanity, and a right to the civic crown.

This means, however, though it subdues the mephitism of the air, would perhaps not act with equal efficacy upon walls, which conceal, deep within their pores, the miasmata with which they are infected. The activity of time is sufficient for the purpose.

I find in my notes the result of an experiment which I shall relate. Wishing to ascertain the power of lime as a means of demephitisation, I had layers, to the thickness of nine lines, taken away from a wall, before I arrived at a layer that was not yet altered *. The other portion of the same wall, which I reserved for the comparative experiment, was completely deprived of its mephitic impregnation by three successive applications of common white wash (pure water and quick-lime).

* I expose the powder detached from the walls, in a glass vessel, to a gentle heat, and judge by the smell whether or not it has been altered.

Now

Now lime enters into the compoſition of the milk-paint, and it may be made the baſe of it by ſubſtituting it inſtead of the Spaniſh white.

The painting will become ſtill cheaper by this ſubſtitution, on account of the cheapneſs of the lime, ſo that the toiſe of the painting will coſt only 5 centimes: as to the labour, there can be no want of hands in buildings where great numbers of individuals are collected together, and where every thing ought to be conducted as œconomically as poſſible.

To be able to deſtroy the mephitiſm of the walls in the aſylums of induſtry, indigence, and misfortune, is certainly a great point gained; but the means of preventing the evil, ſo that there may be none that requires to be remedied, is a no leſs valuable acquiſition. Now milk-painting, with the baſe of lime, is the means of preventing the walls from becoming impregnated with infectious miaſmata.

But of what advantage, it may be objected, is the addition of milk and of oil? It is not by a chemiſt that this objection will be made; however this is our anſwer to it. The addition is made becauſe lime has no adheſion to the walls: it cannot be applied in a thick layer; and the ſlighteſt contact cauſes it to come off, on which account walls white-waſhed in the common way ſoil the clothes that come into contact with them. The caſeous part of milk, the addition of the oil, which forms a ſaponaceous ſubſtance with the lime, afford, on the contrary, after the evaporation of the moiſture, a layer that poſſeſſes denſity and coheſion, and is capable of receiving thickneſs; it is a coating, in ſome meaſure varniſhed, which annihilates the poroſity of the ſtone, plaſ-

ter, brick, or wood, and from which we may wipe off the duſt, without laying bare the place which has been painted.

Milk-painting affords another advantage, which I have not mentioned in my memoir, namely, that of checking the nitrification of the walls, which is accelerated by painting in diſtemper.

In fact, glue is an animal ſubſtance, of which one of the conſtituent principles is azot; now the decompoſition of the glue extricates this azot, which is alſo one of the conſtituent principles of the nitric acid, and enables it to combine with the oxygen, with which it forms this acid.

As milk-painting produces no extrication of azot, one of the aliments of the nitrification is removed; not that the caſeous part of milk does not alſo contain azot, but that it does not become decompoſed, nor give this principle the freedom requiſite to enable it to enter into a new combination. Moreover, this painting ſtops up the pores of the ſtone, and interpoſes itſelf between the walls and the nitrifying action.

Supported by the theory which I have juſt explained, by the authority of two of our firſt chemiſts, Citizens Fourcroy and Deyeux, to whom I have ſubmitted my opinion, and, laſtly, by my own experience, I think myſelf juſtified in recommending to the adminiſtrators of hoſpitals, to adopt the *reſinous milk painting* (always ſubſtituting lime in the place of Spaniſh white) as the moſt efficacious, and at the ſame time the moſt œconomical means of deſtroying the mephitiſation of the walls, and preventing it for the future.

LXXI.

LXXI. *On the Means of purifying infectious Air, &c. extracted from a Work of Citizen* GUYTON DE MORVEAU. *By Citizen* DEYEUX.

(Concluded from Page 349.)

ONE grand queſtion, however, ſtill remained to be decided.

It was neceſſary to aſcertain, whether the anti-contagious agents that were propoſed as capable of producing ſuch ſalutary effects, were applicable to all the different kinds of contagion.

The author admits, without heſitation, that it would be contradictory to all evidence to ſuppoſe that all the maladies which a ſick perſon can communicate to a healthy one, have the ſame matter for their cauſe.

However, admitting the diſtinction that has been juſtly eſtabliſhed between the maladies that proceed from certain effluvia ſuſpended in the atmoſphere, and thoſe which are only contracted from the immediate contact of a matter ſometimes alſo inviſible, but more fixed; it muſt alſo be allowed, upon the authority of unequivocal obſervations, that the firſt are thoſe which prevail the moſt frequently, againſt which it is the moſt difficult to guard one's ſelf, and againſt which, conſequently, the neceſſity of preſervatives and anticontagious remedies is the moſt urgent. To this claſs belong the fevers of hoſpitals, jails, and ſhips, and that which occurs in the vicinity of marſhes; in a word, all thoſe malignant fevers which owe their origin to putrid exhalations.

As to the maladies of the ſecond claſs, that can only be contracted by immediate contact; it is alſo admitted that they originate from the preſence of ſome virus, which aſſuredly is not a ſimple ſubſtance, but rather a compound body, which muſt be ſubject to the condition which obtains in all its products, namely, that of undergoing combuſtion, whenever it is brought into contact with oxygen. Hence it appears, that we have already reaſon to preſume that the virus of diſeaſes muſt experience great changes from the action of the oxygenating ſubſtances, and that conſequently their properties muſt neceſſarily be altered.

To ſubſtantiate this concluſion, the author adduces the following facts.

The variolous virus is certainly one of thoſe, the ſpecific contagion of which is the moſt diſtinctly characteriſed; however, it is certain, according to the experiments of Mr. Cruikſhank, that a portion of this virus, mixed with oxygenated muriatic acid, produced no effect, when it was attempted to inoculate with it; whilſt another portion, with which none of the acid had been mixed, communicated the variolous contagion.

It is alſo known, from practical obſervations, that the ſyphilitic virus is deſtroyed by oxygenated mercurial remedies, and that it produces no infection; whilſt the matter taken from the ſame ulcer, without ſuch admixture, produces a chancre, and other venereal ſymptoms.

The hydrophobia, which has hitherto been conſidered as incurable when the malady makes a rapid progreſs, may, however, be attacked with ſucceſs, by touching the wound that has been

made

made by the rabid animal, with powerful oxygenating ſubſtances, before the local nervous irritation has produced the rabific fever.

Finally, the pſoric virus may alſo be deſtroyed by the oxygenating remedies; the effects of which, in theſe caſes, are ſo well known, as to have no manner of doubt reſpecting the ſubject.

It cannot indeed be denied, that it has not been demonſtrated with the ſame degree of evidence, that the oxygenating remedies are capable of acting with equal efficacy upon the virus of the plague, as experiments have not yet been made upon this ſubject; but, if it be permitted us to draw concluſions from mere probabilities, we may aſſert, that this virus, being undoubtedly a compound ſubſtance, muſt undergo, by the action of oxygen, a combuſtion which, whilſt it changes its nature, muſt alſo change its deleterious properties.

From what has preceded it will be ſeen, that the author has done all in his power to make known thoſe means of diſinfection which appeared to him capable of producing ſuch important effects; but, in order to enable his readers to judge for themſelves of the utility of thoſe proceſſes, which, before thoſe which he has pointed out, were in ſome degree of reputation, he has compared them together, and aſſigned to each that rank in the ſcale of utility to which it is entitled.

From this compariſon, which is compriſed in the third part of the work, it appears:

1. That cold water, lime, reſinous ſubſtances, the kindling of fires, the burning of ſimple and aromatic vinegar by throwing it upon red-hot coals, the detonation of gunpowder, &c. ought not

not to be confidered as real prefervatives and anti-contagious remedies, as they do not poffefs the power of decompofing the putrid miafmata.

2. That ordinary vinegar poffeffes, indeed, the power of decompofing the miafmata; but that this power does not exert itfelf in a perceptible manner, unlefs the infected fubftances are immerfed in this acid, or are capable of being wafhed with large quantities of it.

3. That radical vinegar, or acetic acid, produces effects fufficiently rapid; but that the difficulty of obtaining it in large quantities, at a moderate expence, will frequently be an objection againft its ufe.

4. That the fulphuric acid, on account of its great fixity, is not capable of contributing to the difinfection of the air.

5. That the nitric acid is very capable of deftroying the putrid miafmata, but that the ufe of this remedy is ftill attended with fome inconvenience, owing to the impracticability of entirely depriving it of nitrous gas, the action of which is always prejudicial to the health of thofe who refpire it.

6. That the muriatic acid, on account of the prodigious expanfibility of its vapours, which enables them to reach every part of the fubftance upon which we wifh to operate, affords us very great advantages.

7. Finally, that the oxygenated muriatic acid juftly deferves the preference over all the other remedies, not only on account of the promptitude and facility with which it is every where diffufed, but alfo becaufe its action is always certain, and it immediately deftroys all the putrid miafmata, that are either floating in the atmofphere, or fixed upon bodies.

I think

I think I have ſaid ſufficient to enable the reader to form an idea of the work which Citizen Guyton has preſented to the public. I ſhall only add, that it would be difficult to treat a ſubject, like that which forms the argument of this work, in a more methodical, perſpicuous, and, above all, in a more intereſting manner.

All the facts which the author has adduced are ſubſtantiated by vouchers that cannot leave the ſmalleſt doubt of their authenticity; all the experiments which he has recorded have been performed with care and accuracy; and the inferences which he has drawn from their reſults are juſt, and little ſubject to objection; finally, it appears to me, from all theſe reaſons, that the work of Citizen Guyton ought to be gratefully welcomed by all thoſe who, alarmed at the ravages, unfortunately too frequently produced by contagious diſeaſes, have ardently wiſhed that means might be diſcovered for putting an end to the devaſtations occaſioned by theſe ſcourges of the human race.

What is ſtill to be wiſhed is, that the work of Citizen Guyton may obtain all that publicity which it merits; and that particularly phyſicians, and in general all whoſe profeſſional duty it is to watch over the health of their fellow citizens, may receive ſuch a conviction of the efficacy of the means here propoſed, as no longer to heſitate in recommending them to be put in practice. The ſucceſs with which they would be attended would ſoon afford ſufficient motives of encouragement; and, convinced then of the utility of Citizen Guyton's method, they would unite with all the friends to humanity in paying him that tribute of gratitude which his labours have deſerved.

LXXII.

LXXII. *List of Patents for Inventions, &c.*

(Continued from Page 360.)

JAMES WHITBY, of Collumpton, Devonshire, GEORGE BODLEY, of the City of Exeter, Iron-Founder, and JOHN DAVIS, of Collumpton, aforesaid; for a mill for grinding bark. Dated September 3, 1801.

THOMAS GERMAN, of the parish of St. George Bloomsbury, Middlesex, Gentleman; for a method of greatly easing the labour, and lessening the number of horses in the draft of coaches, carts, waggons, drays, and all land carriages whatsoever. Dated September 12, 1801.

THOMAS JOTHAM, of Bradford, Wiltshire, Clothier; for a machine for raising the wool pile or fibres on woollen, cotton, or other piece goods, preparatory to shearing; and for dressing or dubbing cloths, either wet or dry, otherwise than by Geren cards and pickards. Dated September 15, 1801.

ZACHARIAH BARRATT, of Gealing, Nottinghamshire, Cabinet-maker: for a method of grinding corn, or other grain, by a new-invented mill or machine, either moveable or immoveable, and intended to be worked by water, wind, horses, hand, or otherwise. Dated September 18, 1801.

END OF VOL. XV.

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